HISTORY

General

The sound economic growth of the company's service area based on expanding population, manufacturing, processing of natural resources, and other industrial activities, together with the long standing agriculture, livestock processing and commercial distribution aspects provide a broad base for continuing area development. Denver suburban area population ranked fourth in rate of growth among 56 metropolitan suburban areas in a U.S. census survey. An important factor of this growth in addition to new customers' attached, is the increased utilization of electrical service by present customers through additional application of electricity.

In order to keep pace with these increasing demands for electrical service, additional generation was indicated for 1962. After careful analysis, it was decided to install 150,000 kil watts of capacity as the most economical size consistent with growth. This would increase the company's total generating capacity approximately 17 percent and put it over the one (1) million kilowatt capacity mark.

The company's growth rate, while continuing up, had slowed down to a lesser rate than in the previous decade. When it became apparent that the 44,000 kilowatts of capacity from the Cameo Steam Plant, a mine mouth plant on the Western Slope, would be available in 1960, the future generating program was reviewed. After due deliberation by management in which rate of growth, generating capability, design engineering schedules versus increased costs due to material escalation and labor increases, it was decided to delay start of construction for nine months. This interrupted a continuing construction program in the Denver area that started in August of 1948.

The location chosen was the existing plant known as the Cherokee Steam Electric Station, which carries out the naming of plants after Indian Tribes, started in 1948. It is located just north of the City and County of Denver limits in Adams County, Colorado, where the previous two units were installed in 1957 and 1959. The new unit will be known as No. 3 and all facilities necessary can be made by extending those existing except for a new chimney, ash settling pond and circulating water cooling tower with its associated piping and intake.

The general plant arrangement, showing locations of various structures and facilities, is shown elsewhere in this report on Drawing G-130496, "Plot Plan", which is a drawing originally made for Unit No. 1 and revised to include Units Nos. 2 and 3. The architectural features of the station building maintain the motif set up for Unit No. 1 and includes unlined corrugated asbestos siding on steel framing with the turbine and auxiliary bays enclosed and the outdoor type boiler. The frontispiece, a general aerial view, clearly shows the relative positions of all the structures.

The site was originally acquired between 1953 and 1955 and the Unit No. 1 construction was started in August, 1955. The main advantage of this site was that the Public Service Company of Colorado transmission department's Arsenal Junction was located at the southeast intersection of North Washington Street and East 62nd Avenue, which is now the main entrance to the plant. The switchyard installed for Unit No. 1 transferred the junction's switching facilities to its ring bus. A total of eight (8) transmission lines are now installed including one (1) added during Unit No. 3 construction.

The site, specifically, is in the northeast quarter of Section 11, Township 3 South, Range 68 West, and contains 157.398 acres. It is bounded (with exception to 3 tracts) by East 64th Avenue on the north, by North York Street on the east, by the Northwestern Terminal Railroad (Denver and Rio Grande Western Railway) on the south, and by North Franklin Street and its extension on the west. The exceptions to this closure are the C.V. Miller retention (5.5 acres) in the southeast corner, 3 adjacent residences (311.5' x 125) midway along 64th Avenue, and a residence truck farm strip (approximately 200 feet wide) from 62nd to 64th Avenues along Franklin Street. The South Platte River, flowing north, parallels the site immediately east of North York Street. All clearing, grubbing and grading were performed during Unit No. 1 construction and the plant and yard grade Elevation of 5129.5 was established at that time.

The contract authorizing Ebasco Services Incorporated to act as agent for Public Service Company of Colorado to provide engineering, purchasing, factory inspections, expediting and construction services for this installation, was a supplement dated November 15, 1957, (accepted November 27, 1957) to an existing contract dated August 30, 1954, and accepted September 10, 1954.

The Ebasco Engineering Order Numbers assigned to this project were No. 7988 for the generating plant and No. 7989 for the substation facilities. Engineering was started early in 1958 with composite study drawings of equipment location, main and reheat piping systems routings, general arrangements available for review and a preliminary project outline was released July 1, 1958. Electrical engineers were in Denver July 15, 16 and 17 to discuss the electrical design and it was then decided that the generator would be a liquid cooled type. In August, civil and structural engineers were in Denver to review past design and discuss foundation revisions necessary to hold existing spacing for keeping plant and architectural continuity. In September, 1958, an engineering study was made for water requirements and when it was determined that an additional deep well was required, it was drilled before Unit No. 2 construction was completed as an emergency source for plant operation. Mr. G Chao, project engineer, visited Denver in October, 1958, to discuss and finalize the mechanical design. The heating, ventilating and air conditioning design was finalized during various visits to Denver by C J Danowitz, in conjunction with his consulting duties for the new Public Service Company of Colorado office building in Denver.

Construction started June 13, 1961, with excavation by bulldozer in the station building and boiler areas preparing for drilling of caissons. Ground breaking ceremonies took place June 20, 1960, with Public Service Company of Colorado officers, directors and management, the Governor of the State of Colorado, representatives of the local press, members of the financial and banking associations and Ebasco Services Incorporated field construction personnel in attendance.

Trial operation was scheduled for April, 1962, and was realized April 28, 1962. However, the project was considered ahead of schedule and an anticipated late March, 1961, date was shelved when a directive from Public Service Company of Colorado engineering department dated December 6, 1961, added gas as a main fuel. Four (4) burners were to be revised to include gas burning immediately and provisions were made for the remaining twelve (12) at a future date. The additional engineering, purchasing and delivery of equipment and piping, plus the changes to the already installed control equipment and piping which had to be revised for the fuel safety interlock controls kept the project from an ahead-of schedule start up.

The construction work was practically complete by the end of June, 1962, with only painting, road paving and final clean up to be done. Road paving, except for the final seal coat and chips, painting and removing temporary construction buildings were completed by August 24, 1962, in time for an open house on August 27, 1962. The construction office was closed approximately December 1, 1962.

Construction Plant and Facilities

The temporary construction buildings for this project were originally arranged with the temporary field office and warehouse outside the construction area of the proposed six units. Most of the existing barracks type buildings used as employee change houses, shops and storage buildings remained in the original Unit No. 1 location which was outside of the construction area for three units. All buildings utilized for the Unit No. 2 construction were clear of Unit No. 3 construction except two, No. B-17 and B-34, which were relocated to clear the transformer yard extension and the circulating water cooling tower areas, respectively.

The layout and identification of these buildings are shown on field drawing SK-7988-F25 entitled "Construction Plant", and shown elsewhere in this report. The construction office is the same building purchased in 1948, with an additional twelve (12) foot bay added when moved to Cherokee in 1955, with a brick vault built on the north end. One warehouse was originally purchased for the Arapahoe Unit No. 1 project in 1948 and the other was purchased new for Cherokee Unit No. 2 construction in 1957. No new buildings were required by our forces for Unit No. 3 construction facilities.

The two farm buildings existing on the site were again utilized as storage and field engineer buildings and other temporary buildings were erected and dismantled by the following sub-contractors while they were located on the job: Babcock and Wilcox Co., boiler erection; Slattery and Co., plumbing; Rust Engineering Co., chimney construction; Marley Co., cooling tower erection; Insulation Services Inc., piping and equipment insulation; Jamar-Olmen, boiler sheet metal lagging; and the boiler insulator, Insulation Specialties Co. provided a mobile trailer for use as a temporary office.

The existing Miller's deep well was used for the construction potable water supply. Field office sanitary facilities were also those remaining from the Miller property containing cesspool and leaching field. The sanitary toilet facilities for workmen installed for Unit No. 2, north of cooling tower No. 1 were left in place for Unit No. 3 construction.

The permanent railroad spur for the transformer yard was extended for Unit No. 3 and was utilized for material unloading. The temporary spur from the warehouse track to the boiler was relocated by the boiler erector, Babcock and Wilcox Co., and was used by them for moving the steam drum and pressure parts into position. Permanent tracks 1, 2 and 3 were utilized for storing boiler parts and the boiler contractor provided a locomotive crane for unloading, storing and reloading material and switching cars into the construction area. One owned railroad flatcar was available and three others were obtained from the railroad company by the boiler erector on a long-term rental.

The access road and gate from East 62nd Avenue at Franklin Street were utilized for construction access and the future 230 kv switchyard area at the north end of the existing switchyard was enlarged and graveled for use as the construction employee's parking lot.

Construction power was obtained from five (5) transformer power banks existing from the Unit No. 1 and No. 2 construction programs. The source was a cubicle in the 4160 volt switchgear furnished with the Unit No. 2 project. The power bank No. 1 adjacent to the 4160 volt switchgear feeds through existing or new spare ducts in the permanent duct banks to supply load centers in the station building area. The transformer bank locations and various routings of temporary power are shown on field drawing SK-7988-F30, which is included in the drawing section of this report.

No new telephone facilities were required except an underground line from the manhole east of the timekeeper's shack to the boiler contractor's office and the piping erection contractor's temporary quarters.

Heat for the field office building and warehouse office was by electric heaters and the remainder of the temporary construction buildings were heated by saturated steam radiators, supplied by the plants (Unit No. 2) auxiliary steam system.

Compressed air for construction purposes at 100 psi was supplied in several different ways. During the early stages of construction and for work in outlying areas, either of the two portable diesel engine driven, AC-1 (365 cfm) or AC-2 (500 cfm), compressors were used. During the peak of boiler erection, two electric-driven compressors were employed. One was owned by Babcock and Wilcox Co. and our AC-4 (445 cfm) which we skid mounted with a receiver. They were located in a sheet metal enclosed shack at the southeast corner of the boiler and after Babcock and Wilcox completed their work, only the AC-4 was used in the final stages of construction. A four (4) inch rubber covered heavy duty hose served as a riser up the boiler to the header stations at various levels.

Gasoline and diesel oil were purchased from Standard Oil Company and they were dispensed from underground tanks by means of electric motor driven pumps all furnished by them and installed for Unit No. 1.

Oxygen and aceytlene were supplied as required in standard size containers with a three to four day supply maintained in stock at the warehouse. Due to a questionable demurrage agreement with the original supplier, a new order was placed with Acetylene Service Incorporated approximately 1/3 through the job. Babcock and Wilcox Company, during boiler erection, used a propane-oxygen arrangement with bottles and regulators located on the grade level at the north side of the boiler with rubber-covered hoses running up the structure with header outlets located at several elevations. The B. F. Shaw Company used individual oxygen and acetylene bottles and the same supplier, Acetylene Service Incorporated, supplied all three contractors on the job.

Construction progress photographs were taken from three main locations: One on top of a 50 foot pole, 125 feet north of boiler column "Ja-14"; another on the top of the slope adjacent to the switchyard; the other from the top of the service water cooling tower. The pole was equipped with a ladder, platform and pully for use by the photographer.

Major construction equipment was owned and transferred from the previous projects. It consisted chiefly of:

One, 50 ton Northwest Crawler Crane with 130' boom and 20' jib
One, 45 ton Northwest Crawler Crane with 130' boom and 20' jib
One, 1 cuyd Marion Crawler Crane with 90' boom and 10' jib
One D-8 Caterpillar Tractor with bulldozer
One D-6 Caterpillar Traxcavator with front loader
One 40 foot flatcar

Minor equipment included: 4 air compressors, 6 pumps, 5 air hoists, 1 concrete mixer, 1 mortar mixer, 1 brick saw, 1 stress relieving machine, 25 welding machines, concrete vibrators, miscellaneous minor equipment and small tools. Other equipment from previous projects was available but was not utilized for Unit No. 3 construction. A minimum amount of equipment was

purchased for Unit No. 3 construction and consisted of two mechanical earth tampers, a magnetic electric drill, and automatic torque control impact wrench the main items purchased.

The vehicles used on this project were new as noted, or owned and transferred from previous construction and consisted of:

One, Ford 4 door Sedan, 1960 (new) - #161
One, Ford Station Wagon, 1960, 6 cylinder, (new) - #160
One, 2 ton, GMC Flatbed Truck - #136
Two, 5 cuyd, GMC Dump Trucks - #146 and #150
One, International Truck, hydralift and winch - #154
One, Mack Truck, A-frame and winch - #152
One, 2-1/2 ton International Truck, A-frame and winch - #155
One, 1-1/2 ton, Mack Truck, Flatbed, 1961 (new) - #162
One, 2 ton Mack Tractor and lowboy Trailer, - #136 & TT1
One, 2-1/2 ton Hyster Truck, fork lift - #158

On occasion, owned equipment was rented to subcontractors or performed work for them under "Work Order." The schedule of rental rates is shown elsewhere in the report as "Owned Equipment Rental Rates Per Hour." There is also a chart, "Equipment Operating Record," which shows a theoretical profit or loss on operating versus job cost, based on a rate per hour schedule which is lower than rental rates of local equipment agencies.

The major subcontractors supplied their own equipment for use on the job and these are as follows: Babcock & Wilcox, 80 ton Manitowoc Crane, 25 ton Locomotive Crane, 30 welding machines, 3 air hoists, special electric driven hoist for drum erection; B. F. Shaw Company, 12 welding machines, 1 stress relieving machine, 3 air hoists; Schriber Decorating Company, all small tools, scaffold and 3 spray pots; W. H. Nichols Company, 3/4 ton rail Motocrane, vibrators and tampers; Winslow Construction Company, 3 DW21 tractors and scrapers, 2 bulldozers and motor operated grader; Rust Engineering Company, electric driven hoist and derrick for chimney erection; Meredith Drilling Company, 50 foot kelly bar earth auger (2); Esco Paving Company, 25 ton Galion pneumatic roller, Barber Greene asphalt paving machine, trucks and Galion road patrol.

On occasion, several pieces of equipment were rented for short term use on the site. These pieces of equipment were mainly a 1 cubic yard Bucyrus Erie backhoe used for station building shale excavation, a 1/4 cubic yard tractor mounted backhoe for trench excavation, 2 electric driven conveyors for ash hopper excavation and a 1/2 cubic yard Unit truck mounted backhoe for storm sewer excavation. Other minor tools and equipment were rented as required for special uses and in one instance, a special type of concrete form tie (Gates) and clamp was rented for cooling tower basin construction.

At termination of this construction project, all owned equipment had to be disposed of due to a Public Service Company of Colorado change in policy in which major construction would be

performed by separate contractors. The various divisions of the company had first choice on all major and minor equipment, and small tools. The balance was then turned over to the salvage department for final disposal.

Safety Program

The safety program was essentially identical with those of the preceeding projects in which we recognize the inherent hazards of building construction. Accident prevention is largely a matter of human relations and, to be effective, the responsibility for education, vigilance and cooperation is the duty of management from top supervision thru sub-foreman.

A 20 minute weekly safety meeting was convened each Thursday afternoon, attended by most of the Ebasco and subcontractor superintendents, supervisors and foreman. Each month a different chairman was appointed from among those who attended regularly. It was the intention that the supervisors and foremen took the highlights and job conditions discussed, and passed them on to his men. Each person attending was given an opportunity to bring up any unsafe practice noted, and then one person was designated by the chairman to see that the condition was corrected. A weekly report of the safety meeting was made up and posted in each craft changeroom.

One of the safety meeting highlights was a movie presented by PSCC demonstrating mouth to mouth resusitation. At the end of the meeting, a wallet size recap of the movie substance was given to each person for ready reference.

A first aid man was on the site at all times with basic first aid material for accidents. Stretchers, blankets, splints, etc., were kept at several accessable places on the job site. Emplcyees having accidents requiring medical attention were taken to a clinic a few miles away by the project car. Emergency cases were sent to the nearest hospital in Denver by ambulance.

Ebasco New York Safety Department furnished the job with safety posters at regular intervals and these were posted in conspicuous places throughout the job site.

Travelers Insurance Company was retained by Ebasco Services to handle all injury and compensation cases for the projects. As Ebasco's agent in dealings with the Industrial Commission of Colorado, it presented all reports, argued all cases, and made all payments as directed by the Commission, in accordance with Colorado law. All lost time or compensable accidents were reported to Travelers on their Form Nos. 40 and 20. Travelers representatives made several unannounced visits to the job site and made recommendations for improvements, based upon their visual inspections.

This project received two (2) awards of Certificate of Achievement in Accident Prevention for the years 1960 - 1961 and 1961 - 1962. The latter year we won the Gold Plaque denoting

our record as the best of all Ebasco Services Incorporated projects. Reproductions of the Certificates and the Lost Time Accident Trend Report presenting the statistics with charts on which these awards were made are included elsewhere in this report.

Labor Policy

Labor procurement policies used on this unit were essentially the same as those used on previous projects since 1948, wherein Ebasco Services Incorporated was the general contractor acting as agent for Public Service Company of Colorado. The following crafts were hired directly and paid weekly on the Ebasco field office construction payroll.

Bricklayers
Boilermakers
Carpenters
Concrete Finishers
Ironworkers
Laborers
Millwrights
Operating Engineers
Pipefitters
Reinforcing Rodmen
Truck Drivers

The construction crafts were paid the wages established in the Denver area. Discharge slips could be issued either by the supervisor or by the general foreman, after consulation with the general construction supervisor.

Crafts employed by the sub-contractors are included in the following:

Asbestos Workers
Boilermakers
Electricians
Glazers
Ironworkers
Millwrights
Operating Engineers
Painters
Pipefitters
Plasterers
Plumbers
Roofers
Sheetmetal Workers
Tile Setters

There was a duplication of crafts employed by Ebasco and the sub-contractors because it was elected to sub-contract the erection of the boiler and its supporting structural steel and to install with our own forces all piping two inches and under in diameter including all instrument piping. Also the condenser, primary air duct, and the breeching were installed with our own boilermakers.

A schedule of wage rates showing the rates in effect for all crafts at the beginning of the job, with all subsequent increases until completion, is shown elsewhere in this report.

The Ebasco field supervisory personnel was practically a new organization for the first time since the Denver area construction program started in 1948. The only personnel reassigned being the Construction Superintendent, Construction Accountant and Electrical Supervisor. The Resident Engineer, Construction Engineer, Office Engineer, Cost Engineer, Field Engineer, General Construction Supervisor, Mechanical Supervisor, Piping Supervisor,

Purchasing Agent and Material Supervisor were all transferred from other Ebasco projects and were carried on the New York payroll. All other field office personnel were hired locally.

The job was prosecuted on a 40 hour, 5 day work week, with overtime being used only where absolutely necessary. The overtime before the preliminary and start up operations was mainly for concrete construction on large extended pours or cement finishing which could not be completed in the workday. Preheating and stress relieving of some high pressure welds could not be scheduled to complete during regular eight hour days. During the early months of 1961, Sturgeon Electric Company worked two Saturdays making changes in the temporary construction power supply and again on October 7, 1961, to move the construction power transformer at Unit 1 4160 switchgear to make room for additional switchgear cubicles.

On Saturday and Sunday, October 14 and 15, 1961, a small composite crew of ironworkers and millwrights worked to move the head pulleys, extend and splice the conveyor belts from Unit 2 to Unit 3. A complete outage of the coal conveyor No. 5 was required for this work, therefore, the overtime work was done to coincide with a scheduled outage by the operating department for other work they were performing.

On Saturday, March 10, 1962, a small crew of pipefitters, boilermakers and electricians worked as a standby crew to correct any difficulty encountered during the early part of the "dry-out" and "boil-out" program. On Saturday, April 7, 1962, one pipefitter worked to be available during the "blowing-out" of the cold reheat piping system. On Friday, April 14, pipefitters worked overtime to revise the "blow-out" piping from the hot reheat intercept valves and Saturday, one pipefitter worked for availability during hot reheat piping system "blowing-out".

On Saturday, April 21, all pipefitters worked and on Saturday, April 28, pipefitters used on control piping worked to meet scheduled trial operation items.

The total overtime worked on this project amounted to just over five thousand (5078) manhours, which is .0077 percent or approximately three fourth (3/4) of one (1) percent. This is an exceptionally fine construction record for the type of work involved.

Labor relations during the construction of this project were very good, with the various local Business Representatives of the Building Trades Unions displaying a cooperative spirit. Work assignments and disputes were handled according to the procedural rules of "The National Joint Board for Settlement of Jurisdictional Disputes." There were four work stoppages, all of which were unauthorized.

The first work stoppage occurred on December 7, 1960, when the carpenters voted not to start to work because they did

not agree with an assignment of erecting steel beams for supporting the turbine pedestal forms, to the ironworkers. The carpenters were ordered back to work by their international officers and they returned to work on December 15, 1960. This walkout did not affect the schedule as the carpenters could not proceed with the forming until the supports were erected.

The major work stoppage resulted from a "wildcat" picket line placed on the job on July 24, 1961, by the shop employees of Babcock and Wilcox Company at Barberton, Ohio. This strike was the result of an expired contract between the Babcock and Wilcox Company and their shop employees and caused work stoppages on several jobs over the nation where B & W had erection work in progress. As soon as the local building trades unions were apprised of the true facts about the picket line, they ordered all workmen to return to work except those working on the boiler erection for Babcock and Wilcox Company. The picket line remained on the job until August 17, 1961, at which time the Babcock and Wilcox employees returned to work.

On January 3, 1962, the operating engineers walked off the job; on January 4, they did not show up for work; and on January 30 they placed an unauthorized picket line at the gate due to a jurisdictional dispute with the linemen over the operation of cranes and winch trucks for erection of transformer trim and tower structural steel. The picket line was removed early on January 31, 1962, and all crafts returned to work.

On March 5, 1962, the millwrights walked off the job at 3:00 p.m. because of a jurisdictional dispute with the pipefitters over the erection of linkage between the controllers and the dampers on the coal pulverizers. They returned to work at 8:00 p.m. on March 7, 1962, to await a decision by their international representatives.

Purchasing - General

Ebasco handled procurement of both equipment and materials from two offices. The New York office made all purchases of major equipment as well as items of a technical nature. Building materials and supplies, construction equipment and tools were provided through the field office by means of local purchase orders. Some special building and construction services were provided through field construction contracts. All purchase orders, whether issued by New York or the field office, were issued in name of Public Service Company of Colorado by Ebasco Services Incorporated, Agent.

Wherever possible, orders were placed F.O.B. or F.O.B. shipping point with freight prepaid and allowed to destination or for purchaser's account as a separate item. This avoids liability of a Colorado State Sales and Use Tax of 2 percent on material that is not applicable on transportation charges. Purchases made from local vendors or placed through local sales agents accruing to sizeable dollar amounts are listed elsewhere in this report.

Where feasible, purchases were made through or sales credit given to Colorado agents.

All materials were received at the field warehouse, inspected for loss or damage, and recorded on Material Received Report, (Form 230) in quadruplicate. Material was issued on Requisition on Stores - (field form), for charging directly to the proper construction accounts.

Invoices were received from vendors in triplicate and, upon checking with Material Received Reports, prices, discounts, etc., were paid by Ebasco Voucher Checks, Form 107. A Voucher Payable, Form 106, was prepared in duplicate to support the Voucher Check. The original of the Voucher Payable was submitted to the Public Service Company of Colorado's Auditing Department with a reimbursement request and the copy was retained in Ebasco's field accounting office.

Purchasing - Ebasco New York Office

The design engineer responsible for mechanical, electrical, architectural-structural or concrete-hydraulic features prepared specifications for the various items of equipment required and requested the purchasing department to obtain quotations. Inquiries were sent only to approved representative firms manufacturing or supplying the designated item, with copies to Public Service Company of Colorado's Manager of Engineering, with full details. Upon receipt of bids, the originating engineer, in consulatation with the purchasing department, prepared a comparison of bids statement summarizing the various proposals. These statements were transmitted with one copy of each bid to Public Service Company of Colorado's Manager of Engineering, with comments and recommendations for review and purchase instructions.

The originating engineer, upon receipt of purchase instructions, prepared a purchase requisition from which the purchasing department placed the order or contract. Nos. NY-771801 through NY-771942 were used for these purchases and are listed elsewhere in this report.

Supplements to these orders were issued when it was required to record changes in quantities, terms or conditions of the original order.

Engineering inspection and expediting of shop production on all New York orders and specific field orders were handled under the direction of the Chief Inspector of Ebasco.

All traffic matters were discussed with the Public Service Company of Colorado's Purchasing Agent and Traffic Manager, Mr. R T Blanchard, through Mr. F F Beyers, Assistant Traffic Manager, including routing, claims, rates and classifications.

Purchasing - Ebasco Field Office

The purchase of materials, tools and equipment incidental

to construction were handled through the field office by the field Purchasing Agent, as were some installation contracts. Purchase requisition (Form 226) was initiated by the supervisor responsible for its use, signed by the originator, routed to the Cost Engineer for coding to accounts and to the Resident Engineer and/or Construction Superintendent for approvals. These orders were numbered 3C-1 through 3C-1378 inclusive. Orders (contracts) requiring job site labor are listed and detailed elsewhere in this report. Unit prices paid for various construction materials are listed elsewhere in this report.

Field orders or contracts of major monetary importance were handled in a manner very similar to that described above for New York procedure. Field purchases of minor nature were, after approval by the Construction Superintendent or Resident Engineer, placed by the field Purchasing Agent prior to being processed for payment.

Mr. R T Blanchard, Purchasing Agent of Public Service Company of Colorado, acted as consultant on local purchases and conferree on important purchases as to source of supply and placing of business. Mr. J R Birrell replaced Mr. Blanchard after his forced retirement.

Accounting - General

Standard Ebasco forms were used for all accounting purposes. Books of account used on this project were: General Ledger, Form 100A and 100B; Check and Voucher Register, Form 101; Job Control Ledger, Form A-4; and Detail Cost Ledger, Form A-5a field office revision. Books were closed at the end of each calendar month and a Trial Balance, Form A-10 Rev., was prepared from the balances as reflected in the General Ledger. One copy of this report was submitted to the following Public Service Company of Colorado personnel: Mr. L R Patterson, Vice President; Mr L M Robertson, Manager of Engineering; Mr. A Brunkhardt, Property Accountant; and Mr. H Johnson, Auditor; three copies of this report were submitted to Mr. G P Redden, General Construction Auditor of Ebasco Services, Incorporated, New York.

An Estimate of Cash Requirements, Form 114, was prepared as of the last Thursday of each month. One copy was submitted to Mr. L R Patterson, one copy to Mr. L M Robertson, one copy to Mr. H A Mitchel, Secretary and Assistant Treasurer; one copy to Mr. E E Matthews, Director General Accounting; one copy to Mr. A Brunkhardt, one copy to Mr. C Vaughn and two copies to Mr. Redden.

Work orders were issued in numerical sequence covering the accumulation of costs of work performed and materials furnished for the account of contractors, vendors, etc. When New York orders were involved, a copy of the work order was sent to the Ebasco New York purchasing agent. Invoices were prepared and submitted to the vendor or contractor monthly. Mr. Brunkhardt and Mr. Johnson received copies of work orders.

Accounting - General Account

An initial Working Fund of $800.00 was on deposit in the Colorado National Bank of Denver in Denver, Colorado, when the books were opened. A subsequent increase to the working fund was made in the amount of $24,000 on June 7, 1960; another increase to the working fund was made on August 8, 1960, in the amount of $25,000.00 and still another increase to the working fund was made on January 10, 1961, in the amount of $50,000.00. These deposits brought the general account to a total of $99,800.00. This account was disposed of by transferring $100,000.00 to Public Service Company of Colorado by Check No. 7494 dated September 25, 1962.

Accounting - Payroll Account

An initial fund of $200.00 was on deposit in the First National Bank of Denver, Denver, Colorado, when the books were opened. A subsequent deposit of $4,800.00 was made on June 20, 1960, by withdrawal of this amount from the general account. The payroll account was discontinued when the $5,000.00 was deposited in the general account by Payroll Check No. 6559 dated September 10, 1962.

Accounting - Petty Cash Account

A Petty Cash fund of $100.00 was established on May 6, 1960, by withdrawing this amount from the general account. A subsequent increase of $400.00 was made on June 2, 1960. This account was reimbursed from the general account by completion of Ebasco Form No. 111, Petty Cash Reimbursement Request, and the issuance of a general account check made payable to R. J. Dawes, Petty Cash. This account was discontinued when the $500.00 was deposited in the General Account on September 24, 1962.

Withdrawals from the General Account were made by Ebasco voucher checks, Form 107, which required any two of the following signatures: B A Snow, Construction Superintendent; G B Crane, Resident Engineer; R J Dawes, Construction Accountant; and E S Crockett, Construction Manager. Reimbursement of withdrawals from the general account was made by voucher checks issued by the Public Service Company of Colorado upon presentation of Ebasco Reimbursement Requests, Form 109. Withdrawals from the payroll account were by Ebasco payroll checks, Form 159A Rev., requiring one of the aforesaid signatures. Reimbursement of withdrawals from the payroll account were made by issuing Ebasco General Account Voucher checks, supported by a voucher, Form 106, and one copy of the payroll check, Form 159C.

Accounting - Contractors

All field office contracts were let on either a lump sum, unit price or cost plus basis. Ebasco Services, Incorporated, furnished field inspection and supervision to make certain

that proper materials were used and first class workmanship was provided. Materials furnished by contractors were received and reported on Material Received Report, (Form 230). Materials may or may not have been furnished by the contractor. Contractor's daily time sheets, Form 202, were prepared by the contractors' foremen for cost plus contractors; check sheets, Form 153, were made by the time checker. The time checker made field checks at least twice a day on all contractors.

Payment on lump sum contracts was made at periodic intervals after submission of an invoice by the contractor and approved by Ebasco engineers.

Payment on unit price contracts was made monthly on a contractor's estimate, Form 502, which was prepared by the cost department, checked by the resident engineer and construction accountant, and approved by the construction superintendent. Each contractor submitted an invoice which agreed with the monthly contractor's estimate.

Payments on cost plus contracts were usually made monthly after submission of an invoice by the contractor, with proper support of daily approved time sheets and Material Received Reports.

Final payments to all contractors were made after quantity checks and determination of satisfactory workmanship. A form letter recommending approval of final payment, was submitted to Mr. L M Robertson, Manager of Engineering of Public Service Company of Colorado and to Mr. E S Crockett, Construction Manager of Ebasco Services, Incorporated. After approval by these two parties and by Ebasco's Resident Engineer, Construction Accountant, and Plant Betterment Engineer (when available), and Construction Superintendent, the final payment was made.

Insurance coverage set forth below was required by all contractors and certificates of insurance were furnished Ebasco Services, Incorporated, by the contractor's insurance company on Form 256:

TYPE OF COVERAGE	LIMITS	
WORKMEN'S COMPENSATION AND EMPLOYER'S LIABILITY, including coverage under United States Longshoremen's and Harbor Worker's Act where applicable	Statutory	
PUBLIC LIABILITY	$ 100 000 Each Person	$ 300 000 Each Accident
PROPERTY DAMAGE including coverage for damage caused by blasting, collapse or structural injury, and/or damage to underground utilities	$ 100 000 Each Accident	$ 200 000 Aggregate

TYPE OF COVERAGE--Contd.	LIMITS--Contd.	
CONTRACTOR'S PROTECTIVE PUBLIC LIABILITY	$ 100 000 Each Person	$ 300 000 Each Accident
CONTRACTOR'S PROTECTIVE PROPERTY DAMAGE	$ 100 000 Each Accident	$ 200 000 Aggregate
CONTRACTUAL PUBLIC LIABILITY in accordance with agreement(s) between owner and contractor	$ 100 000 Each Person	$ 300 000 Each Accident
CONTRACTUAL PROPERTY DAMAGE in accordance with agreement(s) between owner and contractor	$ 100 000 Each Accident	$ 200 000 Aggregate
AUTOMOBILE PUBLIC LIABILITY, covering all automobiles, trucks, tractors, trailers, motorcycles, or other automobile equipment whether owned or rented by the contractor, or owned by employees of the contractor	$ 100 000 Each Person	$ 300 000 Each Accident
AUTOMOBILE PROPERTY DAMAGE	$ 50 000	

Accounting - Payrolls

Payrolls were prepared weekly and payment made by check. Payroll periods were from 12:01 a.m., Monday, through 12 midnight, Sunday, with payment being made to employees late the following Wednesday afternoon for field employees and on the following Monday for office employees. Field employees were checked in each morning by picking up their own numbered brass checks from time checker, the number corresponding with the celluloid numbered badge issued to each employee. Ebasco time checker made a morning check and an afternoon check on all employees on the job. A final check was made when each employee turned in his brass check before leaving the job site.

Regular Ebasco forms were used by the timekeeping department, as follows: Employment Card, Form 150; Change of Rate Notice, Form 151 and 151A; Notice of Discharge-Quittance, Form 152; Daily Check Sheet, Form 153; Foreman's Daily Labor Report, Form 154A; Employee Time and Tax Record, Form 155A Rev.; Payroll check, Form 159A; Payroll check copy, Form 159B and 159C; Payroll Computation, Form 166; and Distribution of Manhours, Form 167.

Each foreman prepared and turned in daily time sheets for employees under his supervision which were checked against the time checker's daily check sheet. Time reports were submitted to the cost engineer for account classification coding and then given to the timekeeper for extending and posting to

the Time and Tax Record. Foremen's reports were then posted to Distribution of Manhours, Form 167 and these sheets were balanced weekly to the hours posted in the Employee Time and Tax Records. Form 167 was then totaled monthly, which in turn, was balanced to the monthly totals of the Employee Time and Tax Records. Foremen's reports were balanced dollarwise only to the Time and Tax records. Payroll Computation, Form 166, was then computed and the average rate, by craft, for Insurable Payroll and Gross Payroll was posted to Form 167. Form 167 was then extended and recapped by account. These sheets then became the basis for the monthly payroll distribution journal. The Foremen's reports, along with the check sheets, became a permanent part of the field copy, voucher payable. Distribution of Manhours, Form 167, became a permanent part of the field copy of the Payroll Distribution Journal.

Distribution of Manhours, Form 167, was given a Workman's Compensation code and the Workman's Compensation, Public Liability and Property Damage Report, Form 253, was prepared from these forms.

Payroll deductions were made from employees' earnings consisting of Federal Old Age Benefit Taxes, Federal Withholding Taxes, and State Withholding Taxes. Amounts withheld from employees for Federal and State Income Taxes and Old Age Benefits, along with the employer's contribution for Old Age Benefits, Federal Unemployment and State Unemployment Taxes, were reported on Forms 161, 162 and 163 and remitted to Ebasco New York office for transmittal to the proper governmental authorities.

Insurance

Insurance coverages are handled by both Public Service Company of Colorado and Ebasco and are completely detailed in the project Memorandum of Organization and Procedure dated December, 1960. Preparation of reports for premium determination, preparation of accident reports and settlement of claims are also set forth in the aforementioned report.

Insurance provided by Public Service Company of Colorado:

1. Builders Risk - Fire and Extended Coverage
2. Automotive Fire and Theft
3. Boiler and Unfired Pressure Vessels
4. Excess Transportation and Installation

Ebasco will be named as an additional insured under such coverage.

Insurance Coverages of Ebasco Services Incorporated:

1. Workmens Compensation - Employers Liability
2. Comprehensive Primary PL and PD (General)
3. Automobile - Primary Public Liability and Property Damage

4. [illegible] and [illegible] for PI and PD
5. [illegible] (Including Auto Mobiles)
6. Transportation and Installation
7. Construction Equipment Floater Coverage
8. Fidelity Bond Coverage
9. Money and Securities
10. Depositor's Forgery

The field office prepared a monthly Insurance Report (Form 283) showing [illegible] for payrolls. The report was used as a basis for determination of premiums for Workmens Compensation, Primary and Excess Public Liability and Property Damage insurance. The [illegible] is the original and five (5) copies to G P [illegible]den, Ebasco New York, one (1) copy to H J Johnson, Auditor Public Service Company of Colorado, and one (1) copy held in the field [illegible] Accounting Files.

The Transportation and Installation Insurance Report is distributed as follows: Original and one (1) copy to G P Redden, Ebasco New York, one (1) copy to C Lazarus, Supervisor Insurance and Property [illegible], Public Service Company of Colorado, and one (1) copy retained in the field office Accounting Files.

Field Contracts

Certain features of construction work were performed by contractors working under the direction and supervision of Ebasco field personnel. Most contract work was placed on a lump sum or unit price basis, and some work was performed on a direct cost plus a fee or percentage to cover expense, overhead and profit.

For major contracts, the construction manager's office in New York prepared and forwarded proposals for the work to the field office. [illegible] qualified bidders selected by the construction [illegible] and approved by the engineering manager of Public Service Company of Colorado. After the bids were received and analyzed, a Comparison of Bids form was completed and transmitted [illegible], the construction superintendent to Public Service Company of Colorado with a letter of comments and recommendations [illegible] the contract.

After approval [illegible] Public Service Company of Colorado, a letter of intent was sent to the successful bidder and his proposal was sent to the [illegible] construction engineer's office in New York where a contract [illegible] the work was prepared and sent to the field office for execution and distribution. Regrets were sent to the unsuccessful bidders. Each contract was let on either of two basic types of Ebasco contract forms:

1. Long Form Type, which includes (a) agreement, (b) bond, (c) [illegible], (d) general conditions, (d) specifications, and (e) drawings.

2. Short Form Type, which combines all the features of the long form contract, except that it is a proposal

and acceptance type of contract. This type of contract was used where the work to be performed was of a less complex nature or was of short duration.

Distribution of both the long and short form contract was as follows:

Executed Copies

2 - Contractor, whenever bond is required (otherwise one copy)
1 - Public Service Company of Colorado (Documentary File)
1 - Ebasco - Field Office (Accountant)

Conformed Copies

1 - Public Service Company of Colorado's Engineering Manager
1 - Public Service Company of Colorado's Chief Accountant
2 - Ebasco - New York Office
2 - Ebasco - Field Office

A field purchase order was written as a "cover order" for each field contract and was used mainly to assign a purchase order number to the contract. Any changes in the prices, quantities or terms and conditions of the contract were made by writing a supplement to the covering purchase order.

Contracts or purchase orders for the minor phases of the construction were prepared, presented, approved, executed and distributed in the same general manner as the major contracts. The proposals and contracts were prepared by the field purchasing agent and the resident engineer. They did not embody all the contents of the contracts prepared by New York and were patterned along the lines of the Ebasco Short Form Contract. Administrative supervision and inspection of the work under these contracts were provided by Ebasco field office supervisors and engineers. A listing of the Local Contracts is indexed numerically and alphabetically preceeding the contract breakdown shown elsewhere in this report. The breakdown describes the work accomplished along with quantities, unit prices, amount paid and the accounts charged.

Organization

The contract between Public Service Company of Colorado and Ebasco Services Incorporated provided that Ebasco Services Incorporated furnish design engineering, equipment purchases, and construction services for a 150,000 kilowatt extension to the Cherokee Steam Electric Station. A "Memorandum of Organization and Procedure" was issued to outline the Ebasco organization for construction and engineering services, the procedures and details of purchasing and subcontracting, the mechanics of disbursement, and the various reports desired by the client. Ebasco provided the services of E S Crockett, Construction Manager, who

exercised general supervision of the project, approved construction plans and methods, and maintained valuable contact between the client organization, the Ebasco general office, and the field office with periodic visits to the project. T W Mitchell acted as Assistant to the Construction Manager in the New York office.

In the Ebasco general office, the Project Engineer was E Chao and the Chief Coordinator was J R Smith, assisted by E F Cain, Project Coordinator. Operating through the design engineer's office and assisting the Project Engineer were R W Meyer, Mechanical Engineer, R B Harvey, Principal Electrical Engineer, and A F Wahlrab, Principal Architectural-Structural Engineer.

Following is a list of the supervisory and administrative personnel located at the Ebasco field office:

B. A. Snow, Construction Superintendent
G. B. Crane, Resident Engineer
R. J. Dawes, Construction Accountant
G. Faubion, Jr, General Construction Supervisor
J. M. Brooks, Field Engineer
S. H. Harlow, Construction Engineer
B. W. Bates, Mechanical Supervisor
J. J. Vain, Piping Supervisor
G. R. Fickel, Electrical Supervisor
B. H. Cloud, Office Engineer
C. R. Healy, Cost Engineer
W. J. Curry, Purchasing Agent
R. G. Roach, Assistant Accountant
I. F. Carpenter, Jr., Material Supervisor
F. H. Covey, General Labor Foreman
A. R. Collins, General Carpenter Foreman
L. L. Bannister, General Reinforcing Foreman
W. Fee, General Bricklayer Foreman
R. Bondeker, General Piping Foreman
P. A. Callicrate, General Millwright Foreman

Client company personnel with whom frequent contacts were maintained were as follows:

W. D. Virtue, Executive Vice President and Treasurer
W. W. Howell, Vice President Operations & Financial Department
L. R. Patterson, Vice President Electrical Operations
L. M. Robertson, Manager of Engineering
G. C. Farnsworth, Supervisor of Electrical Engineering
C. [illegible]kow, Supervisor of Mechanical Engineering
[illegible] Right, Supervisor of Structural Engineering
A. J. Johnson, Auditor
R. T. Blanchard, Purchasing Agent and Traffic Manager
F. F. Beyers, Assistant Traffic Manager
A. Brunkhardt, Supervisor Property Accounting
C. M. Peterson, Property Accounting

At the jobsite, contracts were maintained at all times with the operating department thru A P Vail, Superintendent of Production, A H Haberland, Superintendent of Denver Steam Plants and L S Burt, Chief Engineer, Cherokee Plant.

Construction problems involving design and/or procedure were handled between New York engineering and/or Construction Superintendent and L M Robertson, Manager of Engineering and his electrical, mechanical and structural department supervisors, namely, G C Farnsworth, C Waselkow and H W Hight respectively.

The contractors supervisory personnel on the principal construction and erection contracts were as follows:

Allis-Chalmers - Boiler Feed Pumps
B. F. Dickinson, Erector
D. Williams, Service Engineer

Babcock and Wilcox Company - Steam Generator & Accessories
R. L. Swinney, District Manager
R. V. Mower, District Service Engineer
J. F. Krikawa, Service Engineer
F. Solty, Service Engineer
W. E. Fowler, District Erector
M. P. May, District Erector
W. M. Davis, Erection Superintendent
C. D. Pennington, Erection Superintendent (temporary)
K. G. Huber, Erection Superintendent
C. L. McLamb, Erection Superintendent
J. Kopernik, Structural Steel Superintendent
P. Shukis, (Air Preheater Corp), Service Engineer
G. Asbell (Air Preheater Corp), District Erector
G. Moyer, (Air Preheater Corp), District Erector
W. R. Markwood, (Diamond Power Co), Service Engineer
W. Roberts, (Insulation Specialties Inc), Foreman - Ins
J. Grolbert, (Jamar-Olmen), Foreman - Sheet Metal Lagging
J. Batchell, (Jamar-Olmen), Foreman - Sheet Metal Lagging
L. LaPorte (Sturtevant Fan Div), Service Engineer

Bailey Meter Company - Combustion Controls
A. L. Danielsen, Regional Manager
F. Horney, Service Engineer
D. Hillson, Service Engineer
D. Visser, Service Engineer

Bedford Division Yuba Consolidated - Gantry Crane
G. T. Hughart, Service Engineer

Black, Sivalls and Bryson - Control Valves
J. Young, Service Engineer

Corrugated Asbestos Contractors - Station Building Siding
M. Booker, Foreman

Esco Paving Company - Asphalt Paving
H. Schomer, Superintendent
M. Ellers, Foreman

General Electric Company - Turbine Generator
C. H. McCabe, District Manager
T. Cowgill, District Manager (Jan, 1962)
R. F. Suits, Erector
G. Tomlin, Erector (temporary)
C. W. Babcock, Service Engineer
D. Seamons, Service Engineer
R. Hopps, Service Engineer
E. Showalter, Service Engineer
A. Anderson, Service Engineer

Ingersol Rand - Soot Blowing Air Compressors
G. H. Stone, Service Engineer
P. W. Weber, Service Engineer

Insulation Services Incorporated - Piping & Equip Insulation
C. E. Bennett, General Foreman
R. H. Grace, Foreman, Insulation
W. Seaton, Foreman, Sheet Metal

Marley Company - Circulating Water Cooling Tower
A. J. Ott, General Foreman

Midwest Piping Company - Piping Fabrication (2-1/2" & over)
J. DiDonato (Bergen Pipe Support), Service Engineer
D. McClure, (Bergen Pipe Support), Service Engineer

W. H. Nichols and Company - Railroad Track Laying
C. B. Mayo, Superintendent

Riley Stoker Corporation - Coal Pulverizer Mills
W. C. Pierce, Erector
J. Izbicki, Service Engineer
J. M. Moore, Service Engineer

Rust Engineering Company - Chimney
L. Anderson, District Superintendent
D. Smith, Foreman, Concrete
R. Toston, Foreman, Brick

Sam Fox Sheet Metal - Metal Flashing
D. Roberts, Foreman

Schriber Decorating Company - General Painting
J. Blair, Field Foreman

B F Shaw Company - Install Piping (2-1/2" & over)
K. E. Clayton, General Superintendent
L. L. Barnes, Field Superintendent

Slattery and Company - Plumbing and Heating, Ventilating and Air Conditioning
R. W. Peterson, Contract Manager
A. Vessa, Plumbing Foreman
R. Witherspoon, Foreman, Heating and Ventilating
R. Hobbs, Foreman, Insulation

Stormberg Carlson - Intrasite Communication
J. M. Zachary, Service Engineer

Sturgeon Electric Company - Electrical Installation
R. Johnson, President
G. Ranzenberger, General Superintendent
C. Gill, Superintendent

United Conveyor Corporation - Ash Handling System
K. R. Phfol, Service Engineer
D. Harper, Service Engineer

Yuba Heat Transfer Division - Condenser
T. W. McHale, Erector
W. Meriwether, Service Engineer

Job Summary

A job summary for this project was issued in June, 1962, and contained the following information:

	Contents	2 pages
	Construction Photographs	2 pages
I -	Project Outline	19 pages
II -	List of Major Material and Equipment	20 pages
III -	List of Ebasco Orders	5 pages
IV -	List of Ebasco Specifications	3 pages
V -	List of Ebasco Design Drawings	12 pages
VI -	Reproduction of General Drawings	43 pages

The project outline of the Job Summary (Section I) is a condensation of the original project outline and that section is being entirely incorporated in, and as a part of, this final report. It will immediately follow the descriptive paragraph of the "Project Outline" in this "General History", section.

Project Outline

A project outline was issued in September, 1958, as a result of the preliminary design engineering and conferences between the Public Service Company of Colorado and Ebasco engineers. After review and approval by Public Service, the engineering design was finalized.

As noted above in the Job Summary, a brief review of the project outline was included in it and even though most of the information is detailed throughout the Specific History section of this report, this condensation will be helpful for quick reference. The extra sheets printed for the summary are renumbered to agree with the consecutive page numbering of this final report.

PUBLIC SERVICE COMPANY OF COLORADO
CHEROKEE STEAM ELECTRIC STATION
1962 - 150,000 KW EXTENSION - UNIT NO. 3

I - PROJECT OUTLINE

INTRODUCTION

This outline covers the installation of a third unit to the Cherokee Steam Electric Station of the Public Service Company of Colorado. Ebasco Services Incorporated was retained to perform the engineering, prepare plans, specifications and bills of material, purchase equipment and material, including expediting and inspection, supervise construction and to perform initial operating functions preparatory to placing Unit No. 3 into commercial operation.

GENERAL

The extension consists of one General Electric 150 mw turbine, operating at 1800 psig throttle pressure and 1000 F with reheat to 1000 F, directly connected to a liquid cooled generator rated at 182,305 kva at 0.85 power factor and 30 psig hydrogen pressure with a capacity of 200,535 kva at the same power factor, but at 45 psig hydrogen.

The steam generator is of Babcock & Wilcox design and is rated at 1,140,000 lb/hr at 1925 psig and 1005 F at the superheater outlet. The boiler unit is designed to operate with either pulverized coal or natural gas firing. Complete with the steam generator are all structures and auxiliaries; such as, forced, induced and recirculating fans, regenerative air heaters, mechanical dust collectors, etc.

Major plant auxiliaries are a surface condenser, cooling tower, boiler feed pumps, extraction heaters, deaerator, main and auxiliary electrical apparatus, and 115 kv step-up substation.

The coal handling and water supply systems installed for the previous units were extended. Additional ash handling and chemical treatment facilities were provided.

IMPROVEMENTS TO SITE

Clearing and Grading

Very little grading was necessary in the area of Unit No. 3, but some fill was required for cooling tower basin, coal storage, trackage, ash settling ponds and all access road relocation. Drainage was extended from the existing services.

PROJECT OUTLINE
(Continued)

Subsurface Conditions

Since Arapahoe shales were encountered at shallow depths, it was possible to support heavy equipment and structural loads, such as turbine and boiler mats, on spread footings from the shales.

Ash Settling Ponds

Two ash settling ponds were located north of Unit No. 3 to facilitate ash recovery.

Railroad Track

The existing plant access and siding trackage was suitable to service the new unit except for extension of points for transformer servicing. Rail sidings for coal car storage were extended by adding tracks 4, 5 and 6.

Roads

The north one-half of the loop road around the plant was relocated further north and beyond Unit No. 3 so as to be clear of construction. An access road was provided to service the main cooling tower No. 3 and the new ash settling ponds.

Yard Lighting

Lighting was added in the yard to augment that now existing and to include those facilities added with Unit No. 3; these involve the unit itself, the general yard similar to Units No. 1 and No. 2, the main cooling tower, switchyard extension and service cooling tower extension. Provision for aircraft warning lighting (inserts only) was made on the stack, similar to Unit No. 1 arrangement.

Yard Sanitary System and Storm Sewers

No changes were required in the yard sanitary system. The existing storm sewer system in the yard was extended to include catch basins required with the new unit. Unit No. 3 circulating water tunnels can be drained into the yard drainage system.

SERVICE WATER SYSTEM

Water Supply

Water is obtained from three services: South Platte River, delivered through the Farmers' and Gardeners' Ditch, shallow wells and deep wells. Farmers' and Gardeners' Ditch water is delivered to two settling ponds on the site.

PROJECT OUTLINE
(Continued)

River Water

This source supplies water for main cooling tower make-up, indirectly for ash water through the main cooling tower blowdown, water treatment transport water and indirectly for fire service.

Shallow Wells

Shallow wells provide a backup to the river water system. It was not considered necessary to install any additional shallow wells.

Deep Wells

Deep well water is utilized for boiler feedwater make-up, the potable and sanitary water supply and the service water cooling tower. The existing system is adequate for Unit No. 3, but extension of the plant piping in order to incorporate service for the Unit No. 3 control room washroom and various drinking fountains was required.

SERVICE WATER COOLING TOWER

The requirements for Unit No. 3 can be handled (except under maximum conditions) by two of the three existing cells, leaving the third cell as a spare.

SERVICE WATER PUMPS

Two additional 1600 gpm pumps were furnished by C H Wheeler Manufacturing Co, thus providing an over-all reserve of 2705 gpm for three units, or one spare pump with 1105 gpm reserve.

SERVICE WATER RETURN PUMPS

A separate service water return tank was located in the basement of Unit No. 3 to accommodate two 2000 gpm vertical Worthington pumps for Unit No. 3 and one additional future 2000 gpm pump for Unit No. 4.

FIRE PROTECTION

Unit No. 3 required four hydrants and was provided with 12 hose racks in addition to the fire protection similar to that provided for Units No. 1 and No. 2.

PROJECT OUTLINE
(Continued)

CIRCULATING WATER SYSTEM

The circulating water system is a divorced closed circuit. It is similar to the arrangement utilized for Units No. 1 and No. 2; however, a separate ash handling system was installed for Unit No. 3, with extension provisions for Unit No. 4.

MAIN COOLING TOWER MAKE-UP

Make-up for cooling tower losses due to blowdown, evaporation and windage is obtained from the Farmers' and Gardeners' Ditch via pond discharge pumps as was done for Units No. 1 and No. 2.

MAIN COOLING TOWER

This tower has nine cells and is designed to handle 95,000 gpm circulating water with a 20 degree approach to a 60 F wet bulb and a cooling range of 15.1 F with 95.1 F water entering the tower. The tower is constructed of Marlith treated Douglas fir.

STATION BUILDINGS

The extension to the station building is of the same general design as the initial construction and the same type of building materials were used. The turbine room, auxiliary bay, pulverizers, hopper bottom of silos and all heaters are located indoors. The boiler with enclosed firing aisle and drum ends, ash hopper area, forced draft and gas recirculation fans, deaerator, separate section to silos and coal trippers are located outdoors. The locker area and office facilities provided with Unit No. 1 (65 two-compartment units) are considered adequate for Units No. 1, No. 2 and No. 3.

STRUCTURE

The turbine mat is 7 feet thick with top elevation at 5125 feet. The sand fill is 4.5 feet in depth and finished floor 6 inches. Additional borings were taken to verify the design based upon the subsoil conditions which were similar to those for Units No. 1 and No. 2. A maximum allowable bearing capacity for combined dead, live and wind loads of 10 tons per square foot was used.

STRUCTURAL STEEL

The structural steel design is similar to Units No. 1 and No. 2, except that high strength field bolting for load carrying structures and common bolts with lock nuts for miscellaneous steel were used.

PROJECT OUTLINE
(Continued)

PLUMBING

A drainage system for the roofs, floors and equipment drains was installed with connections to the existing facilities. The lower floors drain to the sump pit and all drainage is routed toward the Platte River. Drinking water coolers are provided as required by this extension. The main condenser is drained directly to the sewer system. Consideration is given to directing all floor drains to the yard drainage system, thus eliminating the turbine and/or drainage sumps.

LIGHTING

Instantaneous start fluorescent fixtures are used where practical and economical; however, incandescent lighting is also installed, similar to that furnished with Units No. 1 and No. 2.

FUEL AND ASH SYSTEMS

Coal Handling

The installation of Unit No. 3 introduces the handling of Routt County bituminous coal in conjunction with lignite that was used for Units No. 1 and No. 2. The necessity of transferring from one type of coal to the other for silo storage tends to increase the time of handling more than indicated.

At 100 percent load factor with three units, the 600 tph single belt system must be operated 9.0 hours per day, 6 days per week. Extension of the existing system was not necessary except for the lengthening of tripper conveyor belts 5A and 5B to service new coal silos.

Coal Silos

Four 24 ft OD silos are of unlined steel plates and are duplicates of Units No. 1 and No. 2 design, which provided 28 net effective hours storage at 100 percent load factor and 33 net hours at 85 percent load factor.

Ash Handling

The Unit No. 3 system is furnished by United Conveyor Corporation and is a separate pneumatic hydraulic system designed to service Units No. 3 and No. 4. The bottom ash is collected in a 42 hour storage, double outlet, impounded gravity feed type hopper. The outlets are furnished with the necessary sluice

PROJECT OUTLINE
(Continued)

gates, crushers and 60 ton/hr hydraulic jet pumps and are designed to be operated sequentially. The fly ash and dust is removed from the various hoppers by a 25 ton/hr automatic sequentially controlled pneumatic system, using two hydraulic ejectors in series and air separator tank. All ash is conveyed in the same ash line to two 92' x 556' ash settling ponds located between the railroad tracks north of the plant. Pyrites removal from the pulverizers is accomplished using a centrally located hopper into which material can be dumped from wheelbarrows and conveyed hydraulically to the boiler ash hopper. Water for conveying the ash is stored in a 235,000 gal. tank supplied by the circulating water blowdown system from Units No. 1, No. 2 and No. 3. Two C H Wheeler Manufacturing Co Economy 1600 gpm, 315 ft TDH, horizontally split double volute pumps, located inside the plant east of the bottom hoppers, take suction from this tank and supply water to the jet pumps and ejectors. An ash sump pit was constructed in the ash hopper pit for collecting the overflow from the ash bottom hopper, the air separator and the runback of the water remaining in the main ash pipeline when the ash handling system is shut off. Two Allen-Sherman-Hoff 250 gpm, 90 ft TDH rubber lined vertical Hydroseal pumps are installed in this sump to pump the ash water to the ash settling ponds.

GAS FACILITIES

Gas facilities beyond the regulating station are provided at 50 psig, based upon a natural gas analysis similar to Units No. 1 and No. 2. The gas orifices were designed by PSCC using standard conditions of 12.4 psia, 60 F, specific gravity 0.67. Gas is used for lighting off and warm-up on pulverized coal firing. Only four of the total 16 main gas burners were installed on the steam generator; however, all gas valves and pipelines in the plant are sized to handle the full 16 gas burners in the future. The full load gas requirement (all 16 burners) is 26,950 cfm at an output of 1,140,000 lb/hr steam. The main gas control valve and bypass minimum stop valve have reduced inner valves which will be changed when all 16 burners are installed.

STEAM GENERATOR

The steam generator is a Babcock & Wilcox Company balanced draft radiant furnace pulverized coal-gas burning generating unit, with a maximum continuous

PROJECT OUTLINE
(Continued)

capacity of 1,140,000 lb/hr at 1925 psig, 1000 F and to reheat 932,100 lb/hr at 450 psig, 1000 F when supplied with feedwater at 515.6 F and when firing pulverized bituminous coal at the rate of 67.4 tons/hr or natural gas at the rate of 26,950 cfm, inlet air temperature 80 F. Routt County fuel is considered as the design fuel. However, it is estimated that this unit will reach an expected capacity of 1,140,000 lb/hr when fired with 160,000 lb/hr of sub-bituminous coal (lignite), similar to that now being fired on Units No. 1 and No. 2. The unit is semi-outdoor type with enclosures around the ash hopper area up to the operating floor level, a fire aisle enclosure included to the top of the burners, and drum end enclosures. The steam generator includes FD, ID and gas recirculation fans, ducts, flues to the burners, mechanical dust collectors, regenerative air hoppers, and all usual accessories. Space was reserved for a future electrostatic dust collector on the inlet side of the ID fans. Refer to boiler air and gas flow diagrams on Pages 8a and 8b.

Steam coils are provided for air heater protection, using steam from turbine extraction or pressure reduced saturated steam from the boiler drum.

PULVERIZERS

Pulverizers are Riley Stoker Corporation No. 556 duplex drum type coal breaker and pulverizing units, each capable of handling 37,000 lb/hr.

BURNERS

Coal burners are Babcock & Wilcox circular type PL. Four of the total 16 are furnished with ring type multi-stud gas burners. These burners differ from those on Units No. 1 and No. 2 in that each burner is provided with secondary air registers and a retracting impeller firing horizontally and producing a circular conical shaped flame. All burner and coal valve operations are manually controlled from the corresponding operating floor.

FD AND ID FANS

The forced draft fans are Sturtevant No. 4066D air foil, double width, double inlet, air cooled bearings (no blower required), no inlet boxes, inlet screens including inlet vane and outlet damper with control. Two fans were furnished, each capable of handling 795,000 lb of air/hr at 11.4 in S.P., 80 F air temperature and 880 rpm, producing 490 bhp (WR^2 7040 lb-ft^2) under test block conditions at elevation 5130 ft. This represents a margin of 15 percent on volume and 32 percent

PROJECT OUTLINE
(Continued)

on head over maximum continuous output requirements at 1,140,000 lb of steam/hr. Performance of the forced draft fans is as follows:

FORCED DRAFT FANS

Performance at 5130 Ft Elevation - Pulverized Coal

Total Steam Flow, lb/hr	450,000	700,000	1,140,000	Test Block
Air Flow, lb/hr/fan			692,000	795,000
S.P., in H_2O	3.40	3.95	8.65	11.4
Temperature, F	80	80	80	80
Rpm	880	880	880	880
Bhp/fan			348	490

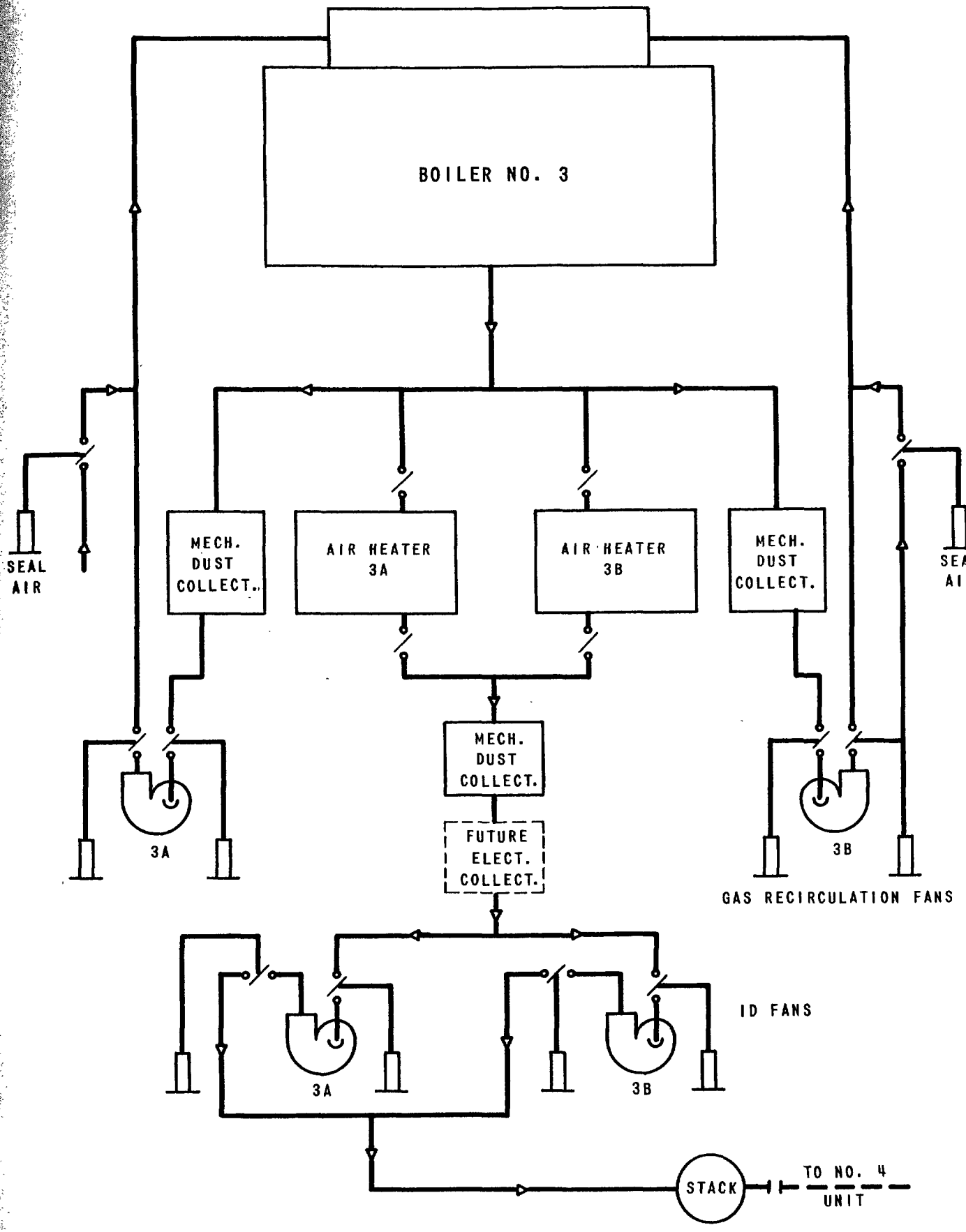
The induced draft fans are also by Sturtevant and are No. 1011TV ID type, double width, double inlet air cooled bearings, inlet boxes, wheel blade liners and inlet vane and outlet damper with control. Two were furnished, each capable of handling 900,000 lb gas/hr at 13.7 in. S.P., 272 F gas temperature and 705 rpm, requiring 1043 bhp (WR^2 51,500 lb-ft^2) under test block conditions at elevation 5130 ft. This represents a margin of 15 percent on volume and 33 percent on head over maximum continuous output requirements at 1,140,000 lb of steam/hr. The head margin includes resistance through a future electrostatic dust collector which will be located on the inlet side of the fans. Manually operated soot blowers are provided for each fan. Performance of the induced draft fans is as follows:

INDUCED DRAFT FANS

Performance at 5130 Ft Elevation - Pulverized Coal

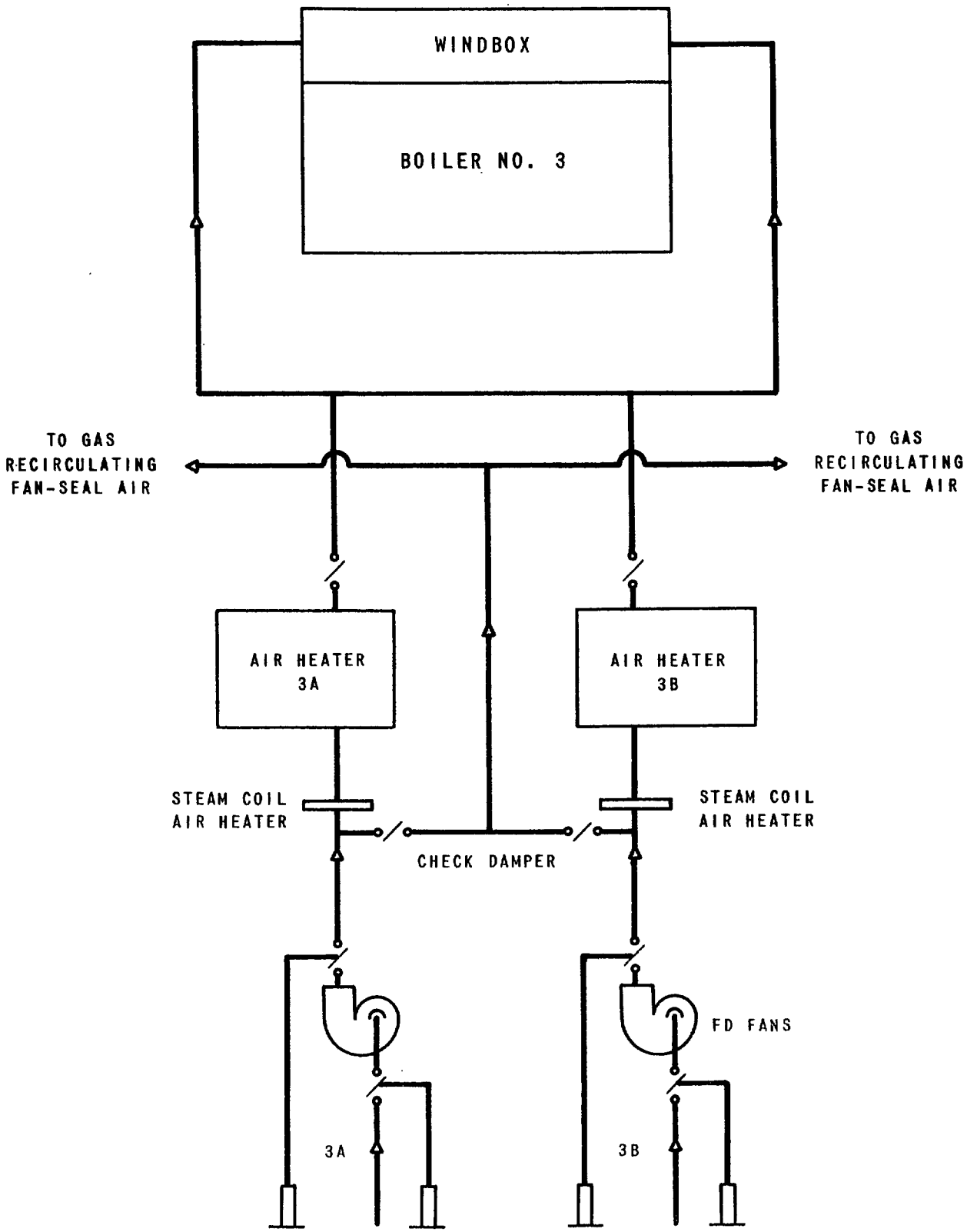
Total Steam Flow, lb/hr	450,000	700,000	1,140,000	Test Block
Gas Flow, lb/hr/fan			782,500	900,000
S.P., in H_2O			10.38	13.7
Temperature, F	240	253	272	272
Rpm			705	705
Bhp/fan			720	1,043

BOILER GAS DUCT CIRCUITS



WAD00726

CHEROKEE NO. 3 - BOILER AIR CIRCUIT



WAD00727

PROJECT OUTLINE
(Continued)

TURBINE GENERATOR

The turbine is a General Electric double flow tandem compound bottom exhaust condensing turbine, with eight extraction stages and rated at 150 mw, 3600 rpm, 1800 psig, 1000 F/1000 F reheat, 3-1/2 in. mercury back pressure, 3 percent make-up, and a guaranteed throttle flow of 1,085,000 lb/hr. It is equipped with all usual accessories, including oil system and supervisory instruments. Turbine start-up is by full arc admission. The generator is liquid cooled and rated at 182,305 kva at 30 psig hydrogen, 0.85 power factor, 3 phase, 20,000 volt, 60 cycle, 0.64 short-circuit ratio. At 45 psig hydrogen the capability is 200,535 kva.

CONDENSER

The 55,000 sq ft, single pass, single shell, vertically divided water box condenser with 29'-9-1/4" x 7/8" diameter tubes is supplied by Yuba Heat Transfer Division. Three can type condensate pumps, two circulating water pumps, along with steam jet air ejector and hogging ejector were furnished by Yuba as part of the condenser order.

The condenser is provided with 48 in. circulating water connections with horizontal inlets on the bottom side and horizontal outlets on the top side of the water box, and is supported from the floor. A rubber "dog bone" expansion is located in the neck between the turbine and the condenser. The low-pressure heater is mounted in the condenser neckpiece.

FEEDWATER HEATERS

There are seven closed feedwater heaters and one deaerator in the feed heating cycle. The four high-pressure heaters (4th, 7th, 10th and 12th stages) are horizontally mounted and contain desuperheating condenser and subcooling sections. The three low-pressure heaters (16th, 17th and 18th stages) are horizontally mounted, the first two having removable shell sections and, in general, are similar to the high-pressure heaters. The third low-pressure heater, however, is mounted in the neck of the condenser.

DEAERATOR

The deaerator is furnished by the Graver Water Conditioning Company and is a horizontal shell, internal direct contact vent condensing type. A 172,300 lb

PROJECT OUTLINE
(Continued)

storage tank is provided. The deaerator is guaranteed to produce 1,200,000 lb/hr boiler feedwater, with no more than 0.005 cc dissolved oxygen.

BOILER FEED PUMPS

Three Allis-Chalmers multi-stage barrel type boiler feed pumps are provided. The automatic recirculation equipment was purchased with the feedwater regulating equipment from the Bailey Meter Company.

FEEDWATER REGULATION

The feedwater to the boiler is controlled by a Bailey three element feedwater control system. The feedwater regulating valve is located between the boiler feed pumps and the high-pressure heaters.

COMBUSTION CONTROL

The combustion control is a Bailey pneumatic system with a range of 8:1.

INSTRUMENTATION

Most of the instrumentation is provided by panels located at various appropriate locations throughout the plant which feed signals to the control room via the relay rack. The unit interlock functions are shown on the accompanying block diagram, Ebasco Drawing No. G-159613.

WATER TREATMENT PLANT

Water treatment is concerned with chlorination of circulating and domestic water, boiler make-up treatment, cooling tower polyphosphate and acid feed and "shot" treatment of boiler feedwater by phosphate, morpholine, etc.

Domestic water is served by No. 2 Deepwell at 10 gph and 300 ft TDH through a hypochlorinator to an elevated 1,000 gallon storage tank. The pump fills the tank at a fixed rate through the chlorinator until full, then is out of service until the tank is nearly empty again.

BOILER WATER MAKE-UP

Evaporators are furnished to provide boiler water make-up. The evaporators receive pretreated well water through sodium zeolite units. Each evaporator is a single effect, horizontal "U" tube type design, including a separate vertical

PROJECT OUTLINE
(Continued)

tray type internal vent condensing preheater and is rated at 25,500 lb/hr net vapor capacity. The vapor is directed to the deaerator, while the coil drains are directed to the main condenser. Continuous blowdown from each boiler is directed to the evaporator and the heat is used to supplement the extraction steam. Shell blowdown is sent through a flash pipe and drains to waste.

CHLORINATION

The service water tower chlorinator was adequate for Unit No. 3 requirements and no changes were made. The main tower chlorinator was also adequate based upon intermittent programmed treatment. The only additional material required was rubber lined pipe and valves between Unit No. 3 tower and the chlorinator.

ACID FEED

Acid treatment for the cooling towers is provided by Milton Roy vertical mersemetic pumps mounted in two 1600 gallon sulphuric acid storage tanks located outdoors north of the water treatment building. Two pumps were installed in Tank No. 2 for Unit No. 3 cooling tower with space for one more pump to service Unit No. 4 cooling tower. This arrangement simulates that for Units No. 1 and No. 2 by providing one pump per two units available as a spare.

POLYPHOSPHATE FEED

Polyphosphate feed is located in the water treatment building and consists of one pump for each cooling tower including the service water cooling tower. Each pump is supplied from a common storage tank.

PHOSPHATE AND SULFITE FEED

Chemical feed treatment of the feedwater is provided by the phosphate and sulfite pumps from separate storage tanks. The phosphate and sulfite systems for Unit No. 3 are similar to Units No. 1 and No. 2 and include two phosphate and two sulfite pumps (one spare in each case) with tanks and provision for two additional pumps to be installed for Unit No. 4.

MORPHOLINE FEED

A separate solution tank and pump were provided and the morpholine is pumped to a point in the boiler feed discharge near the point of sulfite injection. The spare sulfite pump serves as a spare for the morpholine feed system.

PROJECT OUTLINE
(Continued)

HEATING, VENTILATING AND AIR CONDITIONING

VENTILATION

Main plant ventilation air supply for Unit No. 3 is supplied by means of a central fan-washer system located in the fan room at the mezzanine floor elevation in which fresh filtered and evaporatively cooled supply air is prepared using a capillary washer and centrifugal fan with attendant duct work for air distribution. The system is designed to maintain an average indoor plant temperature of 105 F in the summer with outdoor ambient air conditions of 95 F DB - 64 F WB. During the winter 100 percent plant air is recirculated to maintain 70 F at minus 20 F outdoors when the boiler is in service and 45 F when the boiler is out of service. The duct work distributes the supply air to areas throughout the basement, mezzanine, turbine room, switchgear enclosure and firing aisle.

HEATING

In the interest of simplification and economy the induction of fresh air at temperatures below 40 F outdoors is eliminated during the winter season, depending entirely upon the fresh outdoor air that is usually induced through the closed intake dampers by the induction of the main supply fan (S-5) which assumes approximately 10 percent of the total supply air quantity, in this instance 12,000 cfm, and the additional fresh air that enters the plant due to infiltration through building enclosure cracks, crevices, the opening and closing of doors, etc. This arrangement eliminates the need for heating coils, automatic steam supply valves, controls, wiring, etc., for the heating of the outdoor air usually introduced through minimum dampers during the winter as employed in Units No. 1 and No. 2.

Steam is provided for plant space heating in the existing Units No. 1 and No. 2.

Unit No. 3 employs a heating medium of 250 F to 293 F hot water emanating primarily from the station deaerator when plant is operating between 50 to 100 percent capacity. This high temperature water is circulated through a piping system employing hot water unit heaters, thermostatically controlled, which, should the plant equipment heat gain prove insufficient supplies the supplementary heat to maintain 70 F, and 45 F indoors with -20 F outdoors when plant is out of service.

PROJECT OUTLINE
(Continued)

An outdoor bulb thermostat will actuate the plant high temperature water heating system circulating pump at 40 F outdoors and simultaneously close the fresh air intake dampers and open the recirculating dampers in the main fan room.

In the event of a unit scheduled maintenance shutdown or an emergency outage the space heating medium piping interconnection with an adjoining unit is employed and this water returned to the deaerator of the unit supplying it.

Elevation Machinery Room

An electric unit heater 15 kw is provided to maintain 50 F in the elevator machinery room at minus 20 F outdoors, thermostatically controlled.

Snow Melting

Provision in the form of pipe coils embedded in the concrete deck over the coal bunkers has been provided should the need for snow melting become necessary. If they are employed a 50/50 solution of water and ethylene glycol shall be circulated.

Heat Transfer Fan

The function of transfer fan TF-1 is to liberate 20,000 cfm of the high temperature air experienced under the practically over-all floor at elevation 5155.0 ft emanating from the coal mills, their motors, etc., and delivering it to the upper areas of the turbine room there to be exhausted by the roof ventilators.

AIR CONDITIONING - CONTROL ROOM

Air-conditioning service designed to maintain 78 F DB and 50 percent relative humidity at 95 F DB - 64 F WB outdoors for the control rooms for Units No. 3 and No. 4 will be provided by a 20 ton self-contained air-conditioning mechanical refrigeration unit with a water (70 F) cooled condenser, equipped with a high temperature water heating coil.

COAL BUNKER VENTILATION

The coal bunkers shall be exhausted by a "Rotoclone" combination exhaust fan and dynamic coal dust separator.

PROJECT OUTLINE
(Continued)

EXHAUST VENTILATION

Exhaust ventilation for the main plant will be supplied by means of thermostatically controlled powered roof ventilators over the turbine room, heater area, boiler firing aisle, and the steam drum enclosures. The control room kitchen and toilet room will be exhausted by individual ceiling type ventilating fans. A vane-axial fan, duct connected, exhausts the stop valve area, propeller type wall fans exhaust the turbine oil tank and elevator machinery enclosures. Additional exhaust ventilation is effected by the boiler feed pump motor exhaust duct system which discharges into the forced draft fan enclosure.

ACCESSORY ELECTRICAL EQUIPMENT

MAIN SWITCHING, CONTROL AND PROTECTIVE EQUIPMENT

The generator is equipped with a gear driven main exciter, main field circuit breaker with discharge resistor, motor operated main exciter field rheostat and Amplidyne voltage regulating equipment. Bushing type current transformers are provided on the generator main and neutral terminals, for relaying and metering.

The generator neutral is grounded through a 20,000 - 120/240 volt distribution transformer (askarel filled) without a disconnecting device. A resistor and ground relay for tripping the unit are connected across the 240 volt winding. The grounding transformer and resistor are enclosed in steel switchgear type cubicles furnished by the turbine-generator manufacturer.

The indoor portion of the main leads from the generator runs beneath and to the edge of the turbine-generator pedestal and then continues overhead to the building wall. These leads are of isolated phase construction and have a rating of 6500 amperes. Two sets of non-drawout type potential transformers and fused disconnects are furnished in an indoor cubicle, connected to the main leads and mounted below the leads on the ground floor.

The outdoor portion of the generator leads is exposed and will consist of welded bare aluminum pipe with socket type connections at most of the welded joints, to minimize cutting and grinding of pipe in the field. The outdoor leads connect to the low voltage terminals of the three-phase main power transformer.

The generator neutral grounding transformer and resistor are located beneath the generator, at the mezzanine level. The generator field and voltage regulating

equipment are located at the north end of the generator pedestal at mezzanine level. Generator surge protection equipment is located outdoors, beneath the generator main leads and next to the building wall.

The generator and its auxiliaries are controlled from a consolidated boiler-turbine-generator control board (BTG Board) located in the Unit No. 3-4 control room. A BTG auxiliary board is mounted adjacent to and north of Unit No. 3 BTG Board. In the future, Unit No. 4 BTG Board will be located adjacent to the north end of the auxiliary board. The auxiliary board provides additional space for control switches, instruments, recorders, etc., for which there is insufficient room on the BTG Boards.

A cable room beneath the control room contains cable trays for flexible routing of control cables, and also provides space for miscellaneous auxiliary equipment, particularly pilot wire termination facilities and purge protection control equipment.

AUXILIARY ELECTRICAL EQUIPMENT

One - Type OA/FA, three-phase, 12,000/16,000 kva, 19,000 - 4160 volt, unit auxiliary transformer, for supplying the 4160 volt unit switchgear, is connected to the outdoor generator main leads through a 1200 ampere manual gang operated disconnecting switch. Fans were added to existing unit auxiliary transformers No. 1 and No. 2, so that either of these can be used for stand-by duty, in case the Stand-By-Start-Up Transformer is out of service. Fans were also added to the existing Stand-By-Start-Up Transformer, making its rating 12,000/16,000 kva OA/FA.

The control voltage for the majority of the control circuits, including the 4160 volt switchgear, is 125 volts d-c. A new station battery is provided with Unit No. 3, with a tie between the new station battery and the existing Unit No. 1-2 station battery, for stand-by purposes.

The control voltage for the 480 volt a-c motor control center equipment is 120 volts a-c, except for certain vital auxiliaries, such as condensate pumps, pulverizer mill feeders and motor driven control air compressor, all of which have 125 volt d-c control.

AUXILIARY SWITCHING, CONTROL AND PROTECTIVE EQUIPMENT

The unit auxiliary transformer supplies a double bus 4160 volt unit switchgear. The switchgear supplies the larger auxiliary motors directly and the

PROJECT OUTLINE
(Continued)

480 volt switchgear and motor control centers for the smaller unit auxiliaries through 4160-480 volt, three-phase transformers. The 4160 volt switchgear is located outdoors, near the unit auxiliary transformer. The 480 volt draw-out switchgear is located near the north end of the turbine-generator pedestal, in the indoor switchgear room on the ground floor level.

An interconnection between the Unit No. 3 and Common 4160 volt systems is provided. Automatic throw-over from Unit No. 3 auxiliary transformer to the stand-by bus is provided for the condition of a fault resulting in operation of the generator lockout relay. Provision is made for the extension of this bus tie system to all future unit 4160 volt auxiliary systems.

The 4160 volt switchgear is outdoor, heavy-duty, metal-clad type, in a double bus arrangement, with electrically operated air circuit breakers, 1200 amperes continuous rating and 250 mva interrupting capacity. The switchgear is complete with controls, indicating instruments, relays, instrument transformers and accessories as required. The switchgear is connected to the unit auxiliary transformer by means of metal enclosed bus.

Control of all 4160 volt unit switchgear breakers is from Unit No. 3 BTG Board in the control room.

The unit 480 volt equipment is fed from Unit No. 3, 4160 volt switchgear and serves the 480 volt auxiliaries associated with Unit No. 3. The station service transformers are rated at 750 kva, the cooling tower transformer 1000/1150 kva, and the service cooling water and pond discharge transformer 300 kva. The equipment consists of the following:

(a) Two indoor 4160 - 480 volt step-down power transformers, 750 kva, Inerteen filled, each throat connected to a separate indoor draw-out type switchgear assemblage, containing electrically operated air circuit breakers. The air circuit breakers feed five 480 volt indoor motor control centers serving Unit No. 3 auxiliaries within the power plant area.

(b) One outdoor 4160 - 480 volt step-down transformer, 1000/1150 kva, oil filled, throat connected to an outdoor

PROJECT OUTLINE
(Continued)

switchgear and motor control center section serving Unit No. 3 main cooling tower fans.

(c) One outdoor 4160 - 480 volt step-down transformer, 300 kva, oil filled, connected by cable to an outdoor motor control center section, serving the following:

Shallow Well Pump No. 4
Service Water Cooling Tower Fan No. 3
Deep Well Pump No. 4
Service Cooling Water Pump No. 5
Pond Discharge Punp No. 4

The existing common 480 volt system, which is fed from the common 4160 volt switchgear, is extended to include the following additional equipment:

(a) One indoor 4160 - 480 volt step-down power transformer, 750 kva, Inerteen filled, throat connected to an indoor draw-out type switchgear assemblage, containing electrically operated air circuit breakers. The air circuit breakers feed three 480 volt indoor motor control centers for Unit No. 3 extension, serving common auxiliaries within the power plant area.

(b) One outdoor 4160 - 480 volt step-down transformer, 500 kva, oil filled, connected by cable to an indoor motor control center section, serving ash handling equipment common to Unit No. 3 and future units and also ash clinker crushers for Unit No. 3 and future units.

An interconnection between Unit No. 3 and the common 480 volt system is provided, with provision for extension of this bus tie system to all future unit 480 volt auxiliary systems.

Overhead cable trays are used to the greatest possible extent, for routing of control cables indoors. All power cables are run in underground fiber ducts or in exposed or underground conduit.

The 4160 volt and 480 volt auxiliary systems for Unit No. 3 are wye connected, with the neutral grounded through a high resistance, to limit ground fault currents to sufficiently low values to permit continued operation until it is convenient to locate and correct the fault. Alarm relays are provided to annunciate the occurrence of ground faults.

PROJECT OUTLINE
(Continued)

The unit auxiliary power supply system is split into an "A" and "B" group at both the 4160 volt and 480 volt levels. Motor drivers for sets of auxiliaries consisting of two or more identical units are alternately connected to derive their power from the "A" and "B" systems, in order to maintain the maximum degree of reliability possible in the event of an outage of any transformer, switchgear section, power center, control center or associated power cable.

CONTROL OF AUXILIARIES

Electrical controls for motor driven auxiliaries are located generally either at the BTG Board or locally, near the driven equipment. Motors which require controls at more than one point, are kept to a minimum. Such duplication of control points exist only in cases where it is considered absolutely essential.

SUBSTATION EQUIPMENT

TRANSFORMER EQUIPMENT

The generator voltage is stepped up through a three-phase power transformer, rated 180,000 kva, FOA, 19,000 volt delta - 114,000 volt wye (solidly grounded).

OUTDOOR STRUCTURES

The transformer high-voltage leads span overhead to the 115 kv switchyard.

The existing 115 kv switchyard ring bus, consisting of eighteen bays, was adequate to accommodate the Unit No. 3 Extension. However, an additional structural steel take-off tower is provided for generator No. 3 in Bay 13.

Three additional ring bus oil circuit breakers, rated 5000 mva, 1200 amperes, 3 cycles, are provided for Unit No. 3 Extension. Each breaker is isolated with a pair of 1200 ampere, manual gang operated disconnecting switches. Main Power Transfsormer No. 3 is connected to its ring bus section through a 1200 ampere motor operated disconnecting switch.

Tapped to the ring bus section for Main Transformer No. 3 and also the ring tie bus is a set of three single bushing type potential transformers, for relaying, metering and synchronizing. These are used instead of coupling capacitor potential devices utilized for similar applications on Unit No. 1 and No. 2 installations.

PROJECT OUTLINE
(Continued)

The switchyard bus is split into two separate rings. However, until after completion of the Unit No. 3 construction, the rings will be operated as a unit from existing Control Room 1-2. During this phase of operation, the ring tie disconnect switch will remain closed at all times, and all line panels at present in Control Room 1-2 will remain there.

After Unit No. 3 is placed in service, the rings will be operated separately with one ring, containing Units No. 1 and No. 2 generators, controlled from Unit No. 1-2 control room and the second ring, containing Generator No. 3 and future Generator No. 4, controlled from Unit No. 3-4 control room. Two of the existing line panels in Control Room 1-2 will be relocated by PSCC in Control Room 3-4. A new panel, with swinging synchronizing panel, is provided and will be added on the north end of the Unit No. 1-2 line panels, for control of the disconnect switch tying the two rings together. This panel contains a control switch with indicating lights, instrumentation required for power flow measurement between the two rings and relays. A wattmeter, varmeter and ammeter are provided on the new panel for this purpose. A voltmeter is also provided to indicate voltage of Ring No. 2. A similar panel is provided in Unit No. 3-4 control room, which also contains instrumentation to show the power flow between rings and lights only, to indicate the position of the tie disconnect switch. This new panel also has space for control, instrumentation and relaying for a future line in Bay No. 12. Existing line panels will be modified as necessary by PSCC to suit requirements of the Unit No. 3 Extension.

In addition to the panels described above, a new duplex panel is provided in Control Room 3-4, for load-frequency control equipment for Unit No. 3, and a panel for station battery control and an annunciator. This latter panel also has mounted on the front a frequency recorder. On the inside of the rear panel is mounted audio tone channelizing equipment, with sufficient channels for use with Units No. 3 and No. 4 load-frequency control. The load-frequency control equipment for each pair of units is completely independent, and each has its power supply from a separate source.

SPECIFIC HISTORY

LAND AND LAND RIGHTS

No additional land was required or purchased for this project site. The Joseph and Phyliss Rose Satriano Tract No. 1 was purchased in 1957 thru Northwestern Engineering Company who retained the gravel rights for five (5) years. The expiration date was May 1, 1962, and it has been extended unitl November 1, 1962. Gravel removal started December 5, 1961, for state highway grade separation borrow. On April 11, 1962, Northwestern Engineering Company started a gravel plant operation. As a matter of record, this report includes the following field drawings.

SK-5776-F4, Topographic Map - Original
SK-5776-F69, Topographic Map - Final Unit No. 1
SK-6986-F46, Topographic Map - Final Unit No. 2
SK-7988-F33, Topographic Map - Final Unit No. 3

The Unit No. 3 drawing is dated July 31, 1962, and the gravel area contours have not been completed. Some gravel from the Public Service Company property was removed during Unit No. 2 expansion, as noted in its Final Report, and the amount removed from Unit No. 3 can be computed from cross sections.

STRUCTURES AND IMPROVEMENTS

Improvements to Site

Preliminary grading in the station building area was accomplished during the original site preparation for Unit No. 1 construction. Sub-soil investigation was made by Meredith Drilling Company on Order 3C-1, using a small auger, and by Golden Drilling Company on Order 3C-4, who took core samples. The investigation indicated two to five feet of overburden and then varying layers of decomposed brown shale, blue sandstone and blue shale. It was determined that the underlying hard blue grey shale known as the Denver formation, would provide adequate bearing, and drilled caissons were designed to penetrate the overburden and decomposed layers to the solid blue shale. Included in the drawing section of this report are "Sub-surface Profiles", recording all strata as actually found during our excavation work, namely: drawings SK-5776-F40, SK-6986-F12, SK-7988-F32.

Car storage requirements for coal delivered by rail were satisfied by installation of coal storage tracks No. 4, No. 5 and No. 6, consistent with the original scheme of installing three (3) tracks per unit. A contract, 3C-800, was awarded to W. H. Nichols and Company, Incorporated, to furnish all materials and to install 4,376 lineal feet of track, as shown on Drawing SK-7988-F27, "Yard Railroads", located elsewhere in this report. Fill material 12,000 cubic yards, for the embankment of these tracks was spoil from excavation for station building and equipment foundations and was placed and compacted intermittently during the construction program. Spoil, 8,100 cubic yards, from the construction of the ash settling basins was also utilized for embankment.

The transformer track was extended 55 feet by the Denver and Rio Grande Western Railroad Company, Order 3C-591, using material on the job and ballast was supplied by Brannan Sand and Gravel Company on Order 3C-593.

Road work consisted of tieing the north and south access roads together which incorporates paving of the existing east plant road thru the construction area that runs adjacent to the water treatment railroad spur; extension northward of the road west of the transformer area; a connection of the east and west plant roads at the north end of Unit No. 3; an access road to the station building extending west from the east plant road; an access road to the 4160 volt switchgear extending east from the west plant road and a loop road for coal trucks from the water treatment building east to the coal truck hopper, thence south around the south end of Unit No. 1 circulating water cooling tower and then west to tie into the plant road south of the warehouse, as shown on Field Drawing SK-6986-F4 Rev., "Plant Roads", included in the drawing section of this report.

Order 3C-1357 was placed with Esco Paving Company to construct the plant road with concrete gutters (8 cubic yards), placed July 27, compacted eight (8) inch gravel base, two (2) inch asphaltic concrete paving and seal coat with gravel chips. Work was started on July 23, with removal of overburden, and was completed on August 15, 1962, with the seal coat and chipping operation. The following quantities were used for road construction: Compacted gravel sub-base, 4,890 square yards; asphaltic concrete, 4,805 square yards; concrete gutters, 220 lineal feet.

Unit No. 3 circulating water pipe, 72 inch reinforced concrete, over which the coal unloading road passes, was not designed for the loading which would be imposed on it without additional concrete reinforcement. Initially, a concrete cradle was designed for the pipe at this point; however, Public Service Company of Colorado elected to eliminate the cradle. Subsequently, an eight (8) inch reinforced concrete slab was placed over the pipe at road elevation as well as over Unit No. 2 circulating water pipe on August 7, 1962, containing 22 cubic yards.

Concrete gutters were extended along the west side of the west transformer yard road at the toe of the switchyard slope. Gutter was also provided along the west edge of the east plant road pavement.

The area under the gas ducts to the breeching, around the induced draft fans and east to the east plant road was surfaced with a six (6) inch layer of 3/4 inch gravel purchased from Boise-Cascade Sand and Gravel Company on Order 3C-788, totaling 419 tons.

Concrete sidewalks were constructed from the east plant door (D-204) and the ash handling transformer, north to the ash trench; from the forced draft fan enclosure east door at

the north end to the ash trench; and from the forced draft fan enclosure east door at the south end to the road between Units 2 and 3. Concrete (1.67 cubic yards) was supplied by Ready Mix Concrete on Order 3C-17 and placed on April 20, 1962.

No fencing was required for this project.

Yard lighting consisted of an extension to the existing system of two boulevard type light standards along the west side of the transformer yard roadway and two boulevard type light standards along the west side of the east plant roadway paralleling the water treatment spur track. The aluminum poles were purchased for the previous units. The fixtures were purchased from General Electric Company on Order NY-771880. The bases for the four standards were concreted (3 cubic yards) on April 20 and June 18, 1962. Another post type fixture was located at the circulating water cooling tower power and control center, also furnished by Order NY-771880. Its base was concreted (1 cubic yard) on March 26, 1962. Cable pulled to the yard lights was of direct burial type using surplus from Unit No. 2, augmented by Order NY-771899 with Anaconda Wire and Cable Company. All electrical installation was by Sturgeon Electric Company under their general contract.

Fire protection for Unit No. 3 includes a 110 foot long extension to the 12 inch fire line located six (6) feet west of column "A" line parallel to the west wall. The seamless wrapped pipe was transferred to this job from PSCC stores on J-66 and hauled by Weicker Transfer Company, Order 3C-82. Excavation for this line was accomplished during September, 1960, in conjuction with the west wall excavation. A two foot layer of hard blue sandstone overlaid the location and this layer was left in place and shale excavation and the pipe installation was made from the west wall excavation during September, 1960. Concrete was then allowed to encase the pipe (except the fittings and valves) when the footing for the west wall was placed. Hydrant No. 20 and valves 3V-452, 453 and 454 were installed by our pipefitter forces during late November, 1960.

The fire protection extensions are shown on the yard piping Drawing G-159654, and in addition to the line above, a 12 inch steel pipe line at the rear of the boiler to hydrant No. 21 was constructed. The relocation of hydrant No. 3 and the addition of an eight (8) inch pipe line extension northward parallel to and twenty (20) feet west of cooling tower No. 3 with hydrants No. 22 and No. 23 were furnished by PSCC stores on J-136 and hauled to the site by Weicker Transfer Company on Order 3C-276.

The entire underground system is steel pipe coated and wrapped, with the additional hydrants (three) purchased from Grinnell Company on local order 3C-331. The hydrants are Mueller Cat. No. A24016 improved type with two (2) 2-1/2 inch hose nozzles, national standard thread with six (6), 125# flat face flange inlet. Excavation was accomplished with the 1/4

cubic yard rented backhoe and the pipe was installed by our pipefitter forces during early August, 1961. Yard fire protection was tested, pressurized and turned over to the operating department on Equipment Turnover Record No. 17 dated March 12, 1962.

The yard drainage system is shown on Ebasco Design Drawing G-130522 and field drawing SK-6987-F45 and is included in the drawing section of this report. The arrangement for removal of surface water in the area around the station building and boiler, consisting of five (5) concrete catch basins, identified as CB-22 through CB-26 is interconnected with reinforced concrete pipe. It is tied in with existing facilities at CB-18 along the west plant road and with an existing 36 inch reinforced concrete pipe extending east under No. 3 main cooling tower. Provisions were made to tie all electrical manhole and handhole drains into the system.

The station building floor and equipment drainage systems are also tied into the yard system. Catch basin No. 22 collects runoff from the transformer yard, switchyard slope and west side roadway; catch basin No. 23 serves the area north of the station building; catch basin No. 24 accumulates the water in the area north of the No. 3 fan room and runoff from the roadway; catch basin No. 25 is located northeast of the No. 2 chimney to drain water from that area and catch basin No. 26 is in a low area north of future Unit No. 4 and provides a change in direction.

Construction of the catch basins and installation of the interconnecting piping was accomplished during the month of July, 1961, with the exception of the 12 inch reinforced concrete pipe tie between CB No. 18 and CB No. 22. A temporary construction power substation was located in this area and installation was delayed until the substation could be removed. The substation was removed and the line was installed in June, 1962, with excavation in the hard brown and blue sandstone accomplished by air operated hand tools. Excavation for the majority of the drainage system was by use of a 1/4 cubic yard tractor mounted backhoe, rented from Ace-High Sewer Constructors on Order 3C-287. Excavation for the 12 inch reinforced concrete pipe line connecting CB No. 22 to CB No. 23 was accomplished by use of a one (1) cubic yard, Bucyrus Erie Model 30-B, backhoe rented from Gilbert Clark on Order 3C-27. The following quantities of material were used in construction of catch basins and drain line using our labor forces.

Vendor and Order Number

17 cuyd Concrete - Ready Mix Concrete Company, 3C-17
2152 lbs Reinf Steel - Colorado Builders Supply Co, NY-771848
456 feet 12" Reinf Conc Pipe - Lock Joint Pipe Co, 3C-450 & 1347
116 feet 15" Reinf Conc Pipe - Lock Joint Pipe Co, 3C-499
180 feet 18" Reinf Conc Pipe - Lock Joint Pipe Co, 3C-499
208 feet 4" Vit Clay Pipe - Denver Brick & Pipe Co, 3C-482 & 1171
3 each 30" Frame & Covers - Maclear Mfg Company, 3C-502
1 each 22" x 38" Frame & Covers - Maclear Mfg Co, 3C-502

A review of the existing drainage facilities revealed three major inadequancies in the following areas: First, the existing 12 inch drain from 62nd Avenue and Franklin Street was insufficiently sized to handle the runoff from the west and caused flooding in an adjacent field; second, a culvert conveying water from the open ditch, formerly East 62nd Avenue south side, under the Heller ditch was inadequate to handle the volume of water at this point; and third, the existing 24 inch corrugated metal pipe conveying water eastward under York Street to the South Platte River, formerly discharge of East 62nd Avenue south ditch, was inadequately sized and restricted flow.

To relieve these conditions, a 10 inch pipe was installed under the main access road near the entrance gate and was tied into the ditching network along the south side of the construction access road. A 24 inch corrugated metal pipe culvert conveyed this drainage under the construction access road southwest of the field construction office to a new storm sewer system designed by the Public Service Company of Colorado engineering department. This new 30 inch corrugated metal drainage system also removes runoff from the north side of the construction access road and surface water from the Joseph and Phyliss Rose Satriano Tract No. 1, from which the gravel is being removed by Northwestern Engineering Company.

The new storm sewer commences near the northwest corner of the construction office, where it drops into manhole "A", then it bears northeast to an angle point, identified as manhole "B", near the northeast corner of warehouse No. 2, thence south to catch basin "CB-27", located at the northwest corner of cooling tower No. 3, at which point a 36 inch reinforced concrete pipe was extended east to the existing 36 inch line running east under the railroad embankment to catch basin "CB-20".

An inverted siphon, constructed of 36 inch corrugated metal pipe was installed under the Heller irrigation ditch and a new 36 inch culvert of the same type material was installed under York Street to the South Platte River, both paralleling the existing 24 inch culverts.

Work on this additional drainage program was started in May and was completed in June, 1962. Excavation was accomplished for this new system by use of a 1/4 cubic yard backhoe rented from Ace Hi Sewer Contractors on Order 3C-287 and a 1/2 cubic yard truck mounted backhoe rented from Winslow Construction Company on Order 3C-1278. A permit was secured from Adams County thru the Public Service Company of Colorado Gas Street Department to make a cut through York Street with two days required to complete the operation. The excavation was completely backfilled each night and no problem in traffic flow along York Street was experienced. In the process of installing the inverted siphon under the Heller ditch, which is a 24 inch vitrified clay pipe at this point, there was a severe water

problem due to the existing pipe being broken and we subsequently secured permission from the ditch master to shut off flow through the ditch for a day.

The 36 inch reinforced concrete pipe from the temporary catch basin at the north end of No. 3 main cooling tower to catch basin "CB-20" and on eastward to the open ditch at the north end of No. 2 main cooling tower was completely plugged with fly ash dumped into the pipe from the wash water at the ash silo. Cleaning the line was accomplished by pulling a "pig" back and forth through the line utilizing two winch trucks and high pressure water to flush out the broken up deposit. All labor to install the pipe, construct manholes, catch basins and headwalls and to clean the 36 inch pipe was accomplished by our own forces with the following materials used:

29 cuyd	Concrete - Ready Mixed Concrete Company, 3C-17
673 lbs	Reinf Steel - Colorado Builders Supply Co, 3C-1286
30 feet	36" Reinf Conc Pipe - Coppco, Incorporated, 3C-1240
386 feet	30" Corr Metal Pipe - Armco Metal Products, 3C-1241
50 feet	24" Corr Metal Pipe - Armco Metal Products, 3C-1284
252 feet	30" Corr Metal Pipe - Armco Metal Products, 3C-1284
134 feet	36" Corr Metal Pipe - Armco Metal Products, 3C-1284
2 each	30" Frame & Covers - Maclear Mfg Company, 3C-1279
8 lf	24" Vit Clay Pipe - Denver Brick & Pipe Co, 3C-1297

With the decision to build the coal unloading loop road, it was necessary to construct a fill to pass over the Unit No. 3 ash pipe trench and it caused limitations in the yard drainage system. An area north of the truck hopper was impounded by the road fill, railroad embankment and the ash trench. A six (6) inch drain was installed under the ash trench to a new catch basin "CB-28", located southwest of Unit No. 3 intake near electrical manholes No. 18 and 19, constructed over an existing 24 inch reinforced concrete pipe drain and shown on Drawing SK-5776-F37D, "Yard Underground", included elsewhere in this report. Catch basin "CB-28" concrete was placed for the mat (0.5 cubic yards) on August 7, the walls (4 cubic yards) on August 10, and the top slab (0.5 cubic yards) on August 15, 1962. A six (6) inch drain was installed under the road from the coal crusher tower to catch basin "CB-3" at the southeast corner of Unit No. 1 C.W. cooling tower to drain the area around the crusher tower. A ten (10) inch drain with concrete headwall, 0.5 cubic yards, placed August 7, 1962, was extended twenty (20) feet west from catch basin "CB-8" to drain the area at the north end of Unit No. 1 C.W. cooling tower.

Service Water System

The service cooling water system for this unit did not require an extension to the existing cooling tower. The original Unit No. 1 tower contained two cells and a third cell was added for Unit No. 2. The requirements for all three units can be handled (except under maximum conditions) by two of the three cells previously installed leaving the third cell as a spare.

The service cooling water installation consists of two additional circulating pumps for the service water cooling tower located on foundations west of the tower in line with, and adjacent to the north of existing three pumps. A sixteen (16) inch lock joint concrete pipe supply and return line connects the cooling water return tank to the headers at the cooling tower. Two vertical pumps are located on the return tank (one a spare) with provisions for future Unit No. 4 in tank capacity and pump space.

The service water pumps Nos. 4 and 5 were supplied on Order NY-771840 by the C.H. Wheeler Manufacturing Company. The pumps are Wheeler - Economy 8 inch x 6 inch, type MI, centrifugal pumps to pump 1600 gpm at a TDH of 120 feet, in accordance with Ebasco Specification PSCC-C3-114-SWP dated October 16, 1959. The 60 hp, outdoor type motors were supplied by Westinghouse Electric Company on Order NY-771813, and were set by Sturgeon Electric Company under their general electrical installation contract, 3C-149. The pumps and motors were tested and operated on March 8, 1962, and were turned over to the operating department on Equipment Turnover Records No. 22 and No. 23, dated March 15, 1962.

The foundations for the service water pumps No. 4 and No. 5 were hand excavated during the latter part of April, 1961, and sand cement fill was placed between the Unit No. 2 circulating water pipe and the bottom of the pump foundations. Concrete for the service water pump foundations (10.0 cubic yards) was placed May 4, 1961.

The pipe connections from the pumps are shown on design drawing G-159654, "Yard Piping Plan - Sheet No. 1", and they consist of a steel pipe header and valves that connect to a 16 inch lock joint pipe line that runs underground from the pumps to near column "Ha-14" inside the building. The pipe was purchased from Lock Joint Pipe Company on local order 3C-39 with approximately 550 feet installed by Ebasco pipefitter forces during February, 1961, and June, 1961. The header arrangement at the service water cooling tower was fabricated by Midwest Piping Company on Order NY-771889 and was erected by B F Shaw Company under terms of the power piping erection contract, 3C-147.

The cooling water returns from the equipment to the return tank via a cast iron soil pipe system underground shown on design drawing G-159813, "Ground Floor Plan - Plumbing and Drainage", with a connection to the Unit No. 2 drainage system. Slattery and Company supplied and installed the underground piping intermittently during the early stages of construction under terms of their plumbing and drainage contract, 3C-47.

Excavation for the concrete cooling water return tank was performed September 11, 1961, using the 1/4 cubic yard backhoe rented from Ace Hi Sanitary Sewer Company on Order 3C-287. The bottom slab of the concrete tank was placed on September 15, 1961, and the walls were completed September 22, 1961, with a

total of 22-1/2 cubic yards placed. Reinforcing steel was prefabricated and furnished by Colorado Builders Supply Company on Order NY-771848, totaling 2,015 lbs. The steel frame cover for the tank was furnished by Denver Steel and Iron Works on Order 3C-422 and it weighed 2,700 lbs.

The two (2) cooling water return pumps were supplied by Worthington Corporation on Order NY-771839 and are Worthington 12-HH-200, two stage, water lubricated, to pump 2,000 gpm at a TDH of 78 feet, in accordance with Ebasco Specification PSCC-C3-116-SWRP. The pumps were set by our forces during November, 1961, and the two 50 hp motors, were purchased from Westinghouse Electric Corporation as Item 14 of Order NY-771813 and were installed by Sturgeon Electric Company under terms of their contract, 3C-149, during December, 1961. The pumps and motors were test operated February 20, 1962, and were turned over to the operating department on Equipment Turnover Records No. 4 and No. 5 dated March 12, 1962.

The service cooling water system was completely tested, flushed and turned over to the operating department on Equipment Turnover Record No. 18, dated March 13, 1962.

Station Building

The station building extension consists of an enclosed turbine bay 135 feet by 50 feet by 75 feet high; bunker bay 50 feet by 54 feet by 78 feet high; auxiliary bay 48 feet by 68 feet by 41 feet high; fan room 41 feet by 31 feet by 38 feet high; switchgear and cable area 34 feet by 99 feet by 25 feet high with control room 50 feet by 27 feet by 16 feet high. The structure is supported on reinforced concrete footings resting on drilled caissons with concrete floor slab at grade. The west wall of the turbine room up to the operating floor is concrete on a continuous footing. Superstructure is steel framed with walls of corrugated asbestos and concrete block. Floors are poured reinforced concrete, precast flexicore with concrete wearing surface and steel grating. Roofs are poured reinforced concrete, precast flexicore slabs and steel decks with built-up roofing. Exposed roof decks subject to traffic have a concrete wearing surface over membrane waterproofing. Building equipment includes air conditioning (in control room only), necessary heating, ventilating, plumbing, lighting, wiring and fire protection facilities. The areas assigned to the various uses are as follows:

Chemical Feed and Auxiliaries	770	square feet
Switchgear	1,680	do
Pulverizer Area	3,670	do
Turbine Room (2 Floors)	12,460	do
Lube Oil Tank Area (2 Floors)	840	do
Boiler Feed Pump Area	2,700	do
Compressors and Auxiliaries	2,448	do
Ash Pumps and Hopper	1,724	do
Fan Room	1,420	do
Cable Room and Auxiliaries	3,130	do

Control Room	1,770	do
Control Centers and Auxiliaries	680	do
Betterment Area	1,730	do
Heater Levels (2 Floors)	5,000	do
Burner and Firing Aisles (3 Floors)	1,920	do

Contract 3C-9 was signed with Meredith Drilling Company to construct the caissons in the station building and boiler areas. A truck mounted drill rig was moved to the site on June 20, 1960, and drilling operations commenced on June 21, 1960, and were completed on July 12, 1960. Forty seven (47) caissons were drilled, cleaned, reinforced and concreted in the station building area. A total of 103 caissons was constructed under terms of the contract, including those for the boiler structure. 414 cubic yards of class B concrete were supplied by Pre-Mix Concrete Company on a suborder from Meredith Drilling Company for the station building area. The reinforcing steel was supplied by Colorado Builders Supply Company as part of their contract, Order NY-771848. An as-built caisson record is shown elsewhere in this report as Progress Drawing 3C-P-1.

After construction of the caissons was completed, excavation around the caissons for concrete caps commenced on July 18, 1960, using a one cubic yard backhoe rented from Gilbert Clark under terms of Order 3C-27. The final neat excavation and grading were done by our own labor forces using air tools. The first concrete was placed on July 21, 1960, with Uniform panels used for the forms. Concrete totaling 435 cubic yards was placed by Ebasco forces for the station building foundations with the final placement made on October 10, 1960. The Ready Mixed Concrete Company delivered the class B concrete in transit mix trucks. The class B (3000 psi) concrete was set up as a six (6) sack mix initially and when this mix consistently ran over the specified strength requirements, the mix was redesigned for 5-1/2 sacks of cement, resulting in a considerable savings during the course of the job.

Concrete in the walls, grade beams and column encasements totaled 266 cubic yards and was placed intermittently during the construction period with the west wall footing (234 cubic yards) the main placement accomplished on October 5, 1960. The final placement was made on February 22, 1962. Sand cement backfill (1-1/2 sacks per cubic yard) in the station building area was accomplished by our forces using the 16 cubic foot GMC concrete mixer. The sand material was bank run from an unexcavated area in the future station building location to the north adjacent to the construction access road. It was excavated and loaded into dump trucks by the D6 frontloader and hauled to the point of use. The cement was purchased in carload lots in sacks on Orders 3C-72 and 3C-283. A total of 872 cubic yards of sand cement fill was placed in the station building area.

The ground floor paving slabs are shown on design drawing G-159758, "Turbine Area - Paving Plan", and are basically a six inch thick air entrained concrete slab with No. 4 reinforcing steel on 12 inch centers each way, steel trowel finish

with an application of Masterplate floor hardener. The first section of slab was placed April 24, 1961, and the final placement was made January 26, 1962. The sections of floor slab adjoining the pulverizer foundations were delayed due to the late delivery of the equipment and it was necessary to delay the slab construction for maintaining rigging clearances. Concrete totaled 320-1/2 cubic yards and reinforcing steel totaling 24,621 lbs was field fabricated from stock lengths. Masterplate floor hardener, French Gray, non-metallic type was purchased from K-C Construction Supply Company on Order 3C-241 and was monolithically trowelled in.

Several structures are located below the ground floor Elevation 5130, such as the elevator pit northeast of Column "Da-14", the pyrites sump near Column "Da-13", the condensate pipe trench from the condenser to the condensate pumps and the condenser pit. These were started on February 24, 1961, and were completed on October 18, 1961. Concrete totaled 57 cubic yards, reinforcing steel, 2,957 lbs in these structures and miscellaneous frames and covers were purchased from Sterling Steel Company and Metalcraft Welding and Fabricating Company on Orders 3C-77 and 3C-228 and other small local orders.

The structural steel framing was detailed and fabricated by Sterling Steel Company under terms of Order NY-771852, which also included the setting of loose base plates. First delivery of steel was the base plates which were received and set on October 11, 12 and 13, 1960, by Sterling Steel forces. Following this, on October 25, 1960 the initial shipment of structural members was received and erection started on October 27, 1960. Early erection procedures were slow due to the fact that the boiler steel Columns along "D" and 12 lines were not raised until almost two months later, and it was necessary to bolt up and prepare for raising the deaerator and storage tank before any consistent erection could proceed. High strength bolts were used for making the connections and a Chicago Penumatic 610RPT automatic torque control wrench, Skidmore Wilhelm Model M calibrator and a Blackhawk hand torque wrench were used for the automatic torque control method of bolting. Bolting began on December 1, 1960, and it proceeded intermittently until basically completed in June, 1961.

The miscellaneous building steel was included with the main structural steel Order NY-771852 with Sterling Steel Company, but a large number of smaller orders totaling approximately 132 tons were placed for additional items with other suppliers. A partial listing of these items is as follows:

Intake Steel, Turbine Oil Tk Supports	Sterling Steel Co.	3C-77
Cooling Tower Walkways	Sterling Steel Co.	3C-77
Door Sills	Metal-Craft	3C-216
Frames and Covers	Metal-Craft	3C-228
Additional Girt Framing	Metal-Craft	3C-256
Frames and Covers	Metal-Craft	3C-278
Added Steel - Tripper Floor	Metal-Craft	3C-308
Start up Panel Frame	Metal-Craft	3C-470

Flexicore Opening Frames	Metal-Craft	3C-569
Door Frame D-236	Metal-Craft	3C-652
Additional Girt Framing	Metal-Craft	3C-643
Pyrite Cover, Damper Frame	Metal-Craft	3C-725
Stack Hopper, Drum Encl., Pltfms	Denver Steel & Iron	3C-422

Two types of handrail are installed in the station building. Approximately 646 pounds of ornamental rail are shown on Design Drawing G-130626 and were supplied for installation at the stairway on the north end of the pedestal. The aluminum rail is Aluminum Company of America No. 16505 and was supplied by August Friedrichs Company on Order 3C-157 and was erected by our ironworker forces during April, 1962. The standard building handrail is 1-1/4 inch steel pipe with all welded connections, two rails with the top rail 40 inches above the platforms. The fabricator, August Friedrichs Company, elected to measure the handrail requirements in place and fabricate according to field dimensions. Approximately 6-1/2 tons of handrail were supplied on Order 3C-157 and were erected by our ironworker forces beginning the first week of September, 1961, and completed during May, 1962.

The walls of the station building are of varied materials, with the exterior walls corrugated asbestos, supplied and installed by Corrugated Asbestos Constructors on Order NY-771904. Work on the asbestos siding was accomplished in two periods; the first, when the turbine room was enclosed during March and April, 1961, to allow turbine installation to start, and the second, beginning September 25, 1961, until basically completed on November 11, 1961. Interior walls in the betterment area are plaster on structural clay tile; the cable room, switchgear, fan room and turbine oil tank enclosure are painted smooth faced structural tile; and the control room is a combination of solid cinderblock and glazed facing tile wainscot. Above the wainscot to the ceiling height, an acoustical wall is constructed of metal furring channel with sound insulation bats laid in between and covered with 24 inch by 24 inch x 3/16 inch smooth perforated transite sheets with beveled edges. Work on the interior partitions began on November 6, 1961, with two bricklayers being used throughout.

Ceilings in general are the underside of the structural concrete slab above painted off white except the turbine room where the underside of the steel roof deck is tinted blue and the betterment area conference room, where a suspended acoustical plaster ceiling is provided. The control room ceiling is a special arrangement shown on design drawing G-159920, "Lighting - Control Room", with an intermediate suspended ceiling of textured ceiling board panels and a main suspended ceiling of 2' x 4' x 3/8" cell aluminum honeycomb panels. The following suppliers and subcontractors were used in construction of the interior walls and ceilings:

Louverall Ceiling - Material	General Electric	NY-771880
Louverall Ceiling - Installation	Sturgeon Electric Co.	3C-149
Structural Clay Tile	Robinson Brk & Tile Co.	3C-794

Cinder Block	Cinder Concrete Products	3C-796, 888
Glazed Facing Tile	Robinson Brick & Tile Co	3C-794
Building Thermal Insulation	Construction Specialties	3C-816
Dur-o-wall Reinforcing	Rio Grande Company	3C-819, 836
Plaster Walls and Ceilings	Charles W. Johnson	3C-900
Application of furring, acoustic insulation, perf. transite, intermediate ceiling	Jordy and Company	3C-950

The superstructure floors are reinforced concrete with a steel troweled surface containing an application of Masterplate floor hardener, French Gray, non-metallic type. The hardener was purchased from K-C Construction Supply Company on Order 3C-241. The turbine room operating floor is covered with red 6" x 6" x 3/4" red quarry tile, supplied and installed by Reeves Ryan Company on Order 3C-743, which included final waxing and polishing. The control room, kitchen, closet and wash rooms and the conference room in the betterment area are vinyl asbestos tile, Kenflex No. 510, Desert Sand color supplied and installed by Midwest Sales Company on Order 3C-743 as a subcontractor for Reeves Ryan Company. A total of 335 cubic yards of air entrained concrete was placed in the floor slabs by our labor forces beginning March 9, 1961, with the final placement made on October 20, 1961. Reinforcing steel (30 tons) was supplied on Order NY-771848 by Colorado Builders Supply Company in stock lengths and was field fabricated by our ironworker forces.

The roofs of the building are at various elevations and are either 20 year bonded built-up roofing or concrete wearing surface. The turbine room roof at Elevation 5206 is an 18 gage metal roof deck, H H Robertson Company Type 12, purchased from the H H Robertson Company on Order NY-771898 and installed by Sam Fox Sheet Metal Company as a subcontractor for the Robertson Company. Erection of the metal roof deck was accomplished during April, 1961, in order that the turbine room could be enclosed to start turbine installation. The roof of the fan enclosure, firing aisle, and walkways on the north and south end of the boiler at Elevation 5155 are reinforced concrete slab with membrane waterproofing and concrete wearing surface. The remainder of the roofs are flexicore prestressed roof slabs with either built-up roofing or membrane waterproofing and wearing surface provided. Contract 3C-147 was placed with Bacon and Schramm Incorporated, which is all inclusive for 20 year bonded built-up roofing, waterproofing, flashing, sealing and wall flashing. The rot-proof nailer around the roof for the gravel stop was also included in the roofing contract and was installed by our carpenters on a work order. The roofing contractor proceeded to execute his contract intermittently, as required to meet construction needs and a total of 4 separate trips to the project were necessary. Insulation is provided on the turbine room roof and betterment area roof and this is 2 inch and 1 inch thick Fesco Board in 24" x 48" sheets also included in the roofing contract. The contractor was able to employ a power gravel spreader and pump the pitch to the large areas of the turbine room roof.

The first section of concrete wearing surface was placed on October 16, 1961, and the final placement was made on March 26, 1962, with a total of 117-1/2 cubic yards. The joints in the wearing surfaces are sealed with a Thiokol compound supplied and installed by the roofing contractor.

Flashing around pipes and ducts through the walls and roofs is Cohrlastic No. 3016, purchased on Order 3C-846 from Connecticut Hard Rubber Company and installed by sheetmetal workers thru Insulation Services under Order NY-771932.

The doors, frames and hardware were purchased from Richmond Door and Building Specialty Company on Order NY-771917, in accordance with the door schedule shown on design drawing G-159810 with the exception of doors D-204 and D-207 which were supplied out of surplus stock on the job, and D-237 through D-242 which were added later and were purchased on local order 3C-735. The four doors for the fan room enclosure were ordered on 3C-1005. All doors were hung by our carpenter forces with the bulk of them installed during November, 1961, to close the building in for winter. The doors are hollow metal doors throughout, except for the rolling steel door in the west wall which was purchased on Order NY-771920 from Leever Post Incorporated and was installed during early October, 1961. Doors numbered D-216 and D-217 were glazed with 1/4" plate glass under local order 3C-886 with McMurtry Manufacturing Company.

Aluminum window sash is provided in the work room of the betterment area and a plate glass window is located in the conference room and thermopane windows are supplied in the control room walls. The aluminum sash was purchased from Colorado Builders Supply on Order 3C-820; the frames, lintels and mullions for the plate glass and thermopane windows were supplied by Metal-Craft on Order 3C-838 and all glazing was accomplished by McMurtry Manufacturing Company under terms of Order 3C-886 on February 26, 1962.

All painting in the station building was performed by the Schriber Decorating Company on Order 3C-148 in accordance with the "Painting Schedule" reproduced elsewhere in this report and according to the Schedule of Finishes on design drawing G-159809. The contract was written in two parts with the field priming of structural, miscellaneous and coal silo steel with zinc chromate primer accomplished on a unit price basis per ton or square foot and the final coat painting performed on a cost plus basis. All materials were purchased on local orders with the M. L. Foss Company. In general, the paint schedule followed closely the previous schedules for Units No. 1 and 2 except at the request of the client, the tile red exterior paint on handrail and toeplate was changed to silicon red and the exterior structural steel was painted Subalox anti-corrosive aqua.

The 175 ton gantry type station crane was extended to serve the Unit No. 3 turbine room and required the addition of bare copper conductor and insulating supports which were furnished

by Yuba Bedford Division on Order NY-771887 and installed by Sturgeon Electric Company as part of the general electrical installation contract, 3C-149.

The station service elevator is located at the northwest corner of the boiler near the control room for convenient access and available for the next (future) unit at this station. The elevator was supplied and installed by Westinghouse Electric Corporation on Order NY-771872 and is a 2000 pound capacity, passenger elevator with fully automatic selective collective control system, self-leveling device, having a speed of 200 feet per minute. The machine is equipped with an overhead, worm geared, traction type hoist, automatic operating sliding single speed car door and manually opening, self-closing swinging hoistway doors. Erection of the elevator began on October 4, 1961, and proceeded until November 24, 1961, at which time the permanent power supply to the elevator was required but was not available so Westinghouse Corporation pulled off temporarily. Erection resumed on January 24, 1962, with final completion on February 27, 1962, and the elevator was placed in service on that date. The elevator was turned over to the Public Service Company of Colorado on Equipment Turnover Record No. 80 dated June 22, 1962.

The station building heating, ventilating, and air conditioning was installed by Slattery and Company on Order 3C-850. The major mechanical items were purchased on the following orders:

NY-771924	I.L.G. Electric Ventilating	Ceiling Ventilators
NY-771925	Oliver & McClellan Inc.	Electromode Heaters
NY-771926	A.F. Hinrichsen Inc.	Motorized Fans
NY-771927	Buffalo Forge Company	Wall Fan
NY-771928	Gould Pumps Incorporated	Centrifugal Pump
NY-771929	American Standard, Ind Div	Vane Axial Fan
NY-771930	Westinghouse Electric Corp	Air Conditioning Unit
NY-771931	Air & Refrigeration Corp	Capillary Washer
NY-771934	The Airolite Company	Air Intake Filters
NY-771938	American Standard, Ind Div	Hot Water Unit Heaters

Originally Order NY-771933 was placed with the Trane Company for supplying the hot water unit heaters but due to a strike in the manufacturing plant, they were unable to meet delivery schedules and the order was cancelled and placed with the second low bidder.

The contract with the Slattery Company included setting the above listed equipment and supplying and installing all additional materials and incidentals for a complete installation of the heating, ventilating and air conditioning systems of the station. Also included in contract 3C-850 is the supplying of three window type heat pumps for the plant betterment offices. Basically the systems are the ventilating and cooling of the main building by the introduction of outside filtered and cooled air with roof ventilators and wall exhaust fans providing the exhaust circulation. High temperature hot water unit heaters

are used to heat the main building and the control room is cooled and heated by a self-contained air conditioner with HTHW heating coil. The coal bunkers are provided with a dry dust collector for continuous ventilation of the silos, the boiler feed pump motors are provided with ventilation duct and the turbine oil tank area is exhausted with vane axial fans and duct. The elevator machinery room is ventilated by a wall type propeller fan and heated by an electric unit heater; the steam drum enclosure ventilation is accomplished by roof ventilators and wall louvers and it is heated by a 10 kw electric unit heater; the control room toilet and kitchen are ventilated by a ceiling fan and the betterment air is cooled and heated using 3 window type heat pumps and a supplementary unit heater. A filtered air supply to the exciter and exhaust ventilation of the pulverizer area is effected by fan TF-1. Also included in the contract with the Slattery Company is a wrought iron pipe snow melting coil located in the tripper floor wearing surface. Work on the heating and ventilating began on December 12, 1961, and was completed on May 31, 1962.

The station building plumbing is divided into three separate systems which are the storm sewer system, the sanitary sewer system and the drainage system for the cooling water return. Contract 3C-47 was awarded to Slattery and Company for the complete installation of all systems. The underground portion is extra heavy cast iron soil pipe, the leaders are galvanized steel with galvanized cast iron fittings and all potable water is copper with sweat fittings. The contract includes supplying and setting water closet, water cooler, lavatory, kitchen unit and the installation of the conference room sink which was purchased on Order 3C-766. The contractor began installation of the underground systems on December 13, 1960, and proceeded intermittently until they were completed on April 19, 1962.

The lighting system and building wiring were installed by Sturgeon Electric Company on Order 3C-149 which is the general electrical installation contract. The system is a 120/208 volt system supplied through 7 panels numbered LP-26 through LP-32, which were purchased from Penn Panel and Box Company on Order NY-771888. The wiring diagram is shown on design drawing G-159914 and general notes on A-159915 with 12 gauge insulated wire and bare neutral generally used throughout. The turbine room is lighted with 16 Hi-Bay mercury lamps; the switchgear and cable vault room is lighted with fluorescent fixtures and the remainder of the building is generally illuminated by incandescent lamps with reflector fixtures. The control room is illuminated with fluorescent lighting fixtures in continuous runs above a suspended ceiling of 3/8 inch cell honeycomb panels 1/4 inch deep natural aluminum finish manufactured by Hexcel Products Incorporated. All lighting materials were supplied by General Electric Supply Company on Order NY-771880. The installation of the permanent lighting equipment began in the fall of 1961 to minimize the amount of temporary lighting required as the building was closed in and dark areas resulted.

An emergency lighting system is included in the control room and turbine room areas. This system is a direct current system supplied by the d-c generator and storage battery arrangement described elsewhere and is supplied through lighting panel LP-29.

Building Permit

On February 6, 1961, Building Permit No. 10846 was issued by the Building Inspector of Adams County, at Adams City, Colorado. The fee is based on building costs exclusive of equipment excepting building services. For this project, the only building structure was the station building.

BOILER PLANT EQUIPMENT

Coal Equipment

Coal handling facilities installed for Unit No. 1 basically satisfy the requirements for Unit No. 3 consistant with the original design. A new car shaker was installed at the track hopper which will permit unloading of two different types of coal from separate tracks at the track hopper. Lignite used for Units No. 1 and No. 2 can be unloaded over one track hopper and coal with a higher Btu rating used for Unit No. 3 can be unloaded over the other track hopper. Alternate use of the conveying system for storage or bunker filling from either track hopper or truck hopper is possible. It can readily be seen that the handling of two types of coal simultaneously is not feasible.

In the initial planning for Unit No. 3, consideration was given to the type of coal to be used. Use of a low heating value coal, similiar to the lignite used for Units No. 1 and No. 2, would exceed the handling capacity of the coal equipment when this quantity was totaled with the existing units. Subsequently, it was decided to use a coal of higher heating value, similar to the coal available in Routt County, Colorado, as the fuel for Unit No. 3. Although this procedure appeared workable, there was serious limitations including, but not necessarily limited to, proper storage and reclaiming of two fuels for emergency use, and transfer from one fuel to another during unloading and bunker filling operation. In order to facilitate a smooth operation, Public Service Company resolved to use Hanna Coal throughout the entire plant.

A new car shaker and hoist were purchased from Hewitt-Robins, Incorporated, on Order NY-771836 and installed on the existing hoist structure over the west railroad track hopper during June, 1962.

Coal tripper conveyors 5A and 5B were extended an additional 214 lineal feet to serve Unit No. 3 coal storage silos. Stephens-Adamson Manufacturing Company furnished all the equipment; conveyor belts, rails, structural supports, belt carriers, return rollers, zipper seals, cables, switches and two (2) 48'-0" trusses, on Order NY-771835. The trusses that span from Unit No. 2 to Unit No. 3 were erected during the steel erection phase of the project. A temporary support was installed under the north end of the trusses until the silos were erected to provide the permanent support.

Extension of the conveyors was accomplished from August to October, 1961, with the movement of existing drive units and splicing of belts closely coordinated with a period of low load on the existing plant. Conveyor No. 5A was taken out of service on October 12, revised and placed in operating condition before conveyor 5B alteration started and all work was completed on October 20. The existing units were placed on gas fuel during this operation and the precautions outlined above were insurance in the event demands on the gas system

became excessive. Included in the extension of the conveyors was the relocation of the gravity belt takeup, formerly located on the south side of Unit No. 1 coal bunkers to a permanent location, including all future units, on the south side of Unit No. 3 bunkers. Splices in the conveyor belts were vulcanized by Custom Millwright Service Company on Order 3C-798. All other work was performed by our own forces except for the electrical phase. Conveyors were turned over to the operating department on Equipment Turnover Record, Sheets No. 69 (5A) and 70 (5B) dated June 22, 1962.

Raw coal is stored in four (4) cylindrical bunkers, 23'-10" in diameter by 35'-7" high, constructed of 5/16" steel plate with a 17'-7" conical outlet section constructed of 1/2 inch plate. Silos are located in an area bounded by column line 12 on the south, column line 14 on the north, column line "B" on the west and column line "Da" on the east. The silos have a capacity of 16,000 cuft and are designed to support the tripper floor, flexicore roof slabs and all coal conveying and unloading equipment at Elevation 5207.0'. The conical outlet section extends down through the operating floor, Elevation 5155.0', with a slide gate valve and split coal feeder supply duct attached to the 5'-0" outlet.

The fabricator, Sterling Steel and Supply Company, is located in the same general area as the plant which enabled them to fabricate the silos in five cylindrical sections and deliver them to the jobsite by truck. In a like manner, the cone section and ring support section were completely fabricated. These sections were set in place by use of a 40 ton crawler crane. Circumferential welds required to complete the silos were made by our ironworker forces after the men were qualified in accordance with AWS standards in the field.

Sterling Steel and Supply Company furnished the silos on Order NY-771894, the coal feeder duct was fabricated by Metalcraft Welding and Fabricating Company on Order 3C-269, and the coal gate valves were furnished by Fairfield Engineering Company, Order NY-771894. Removal of combustible coal dust from the silos is provided for by use of a roto-clone furnished by E & M Equipment Company, Order NY-771923, and installed with connecting duct work by Slattery & Company as part of their heating and ventilating contract.

Ash Disposal System

A hydraulic-pneumatic ash handling system was introduced for Unit No. 3 with provisions sufficient for Unit No. 4 requirements as shown on design drawing G-159631, "Flow Diagram Ash Handling", included elsewhere in this report. The system provides for complete removal of furnace bottom ash and fly ash. Furnace bottom ash is transported directly from the hopper to ash settling ponds through a pipe line sluiced by means of two (2) hydraulic jet pumps. A complete automatic sequentially controlled fly ash and dust removal system is handled pneumatically by means of a hydraulic jet system with the material transported to the ash settling ponds through the same pipe line that serves

the furnace bottom ash system. Refuse from a small pyrite hopper is transported directly to the furnace bottom ash hopper through a pipe sluiced by means of a sump type hydraulic jet pump. Two clinker grinders are provided and installed on the outlet of the furnace bottom ash hoppers.

Two (2) ash settling basins were constructed in the north area, between coal storage tracks No. 15 (future) and 16 as shown on design drawing G-159767, "Ash Settling Ponds - Plan and Sections". Each basin is 556'-0" long by 92'-0" wide at the top, Elevation 5137'-0" with sides sloped 2:1 to Elevation 5119.0' and 1-1/2:1 exterior slopes. A road, 22'-0" wide, is provided around the periphery of each settling pond. A contract was awarded to Winslow Construction Company for construction of the ponds. Excavation, 20,000 cubic yards, was started on June 16, 1961, with spoil used to construct the impounding dikes and surplus utilized for railroad embankment. Fill used in the dikes was compacted to a standard 90 proctor density and was completed July 10, 1961. The nine inch gravel surfacing for the roads was placed by our own forces from material excavated on the site.

An overflow from the west pond, 36 inch vertical pipe with steel plate skimmer, is supported by a concrete foundation, 0.5 cubic yards, and is connected to the yard drainage system by a 12 inch reinforced concrete pipe from the overflow to catch basin CB 20. A concrete trench, 68'-0" long, with reinforced concrete covers, through the south road allows the sluice pipe to pass under the road. A concrete trench, 38'-0" long with reinforced concrete covers, through the road between the two ponds at the north end, serves as a passageway for the sluice line between ponds and allows the ponds to equalize their respective water levels. Concrete was placed for the south trench bottom slab on October 9, 8.0 cubic yards, and the walls on October 12, 6.0 cubic yards, and for the north culvert bottom slab on October 6, 5.0 cubic yards, and the walls on October 9, 1961, 7.5 cubic yards.

Excavation for the furnace bottom ash hopper foundation and sump was started July 21, 1961, with a front end loader used for this operation. Limited access prevented the use of machinery for the complete excavation and the final cut in shale for the sump was accomplished by use of hand labor and air operated tools with removal and truck loading by rented portable continuous belt conveyor. For a typical cross section of soil stratums in this area, see Field Drawing SK-7988-F32, "Sub-Surface Profiles," located elsewhere in this report. Concrete was placed for ash hopper foundation pit and sump in sections, 116.5 cubic yards, between September 1 and September 15, 1961, with actual placements recorded on construction progress drawing 3C-P-7, "Equipment Foundations", included elsewhere in this report.

Ash collecting and handling equipment were supplied by United Conveyor Corporation on Order NY-771900. Ash is collected at the bottom of the furnace in a hopper, 1090 cubic feet storage, which is brick lined and extinguished in water.

Two (2) clinker grinders are provided, one for each hopper, to reduce the ash to size suitable for handling by two (2) jet pumps. Dry ash from the eight (8) dust collector hoppers, two (2) economizer hoppers, four (4) gas recirculation duct hoppers and the stack is collected by use of hydraulic ejectors. Provisions are made for collecting ash from the air preheater hoppers by either the wet or dry method. When removed wet, it is sluiced back to the main hopper. Pyrites from the coal pulverizers are collected by a jet pump and delivered to the main hopper. Piping for this system was installed by B F Shaw Company and the hopper was erected by our forces.

Water for the ash system is provided by collecting the blowdown from the circulating water system and storing it in a 250,000 gallon tank. A 6 inch emergency supply is provided from the 18 inch cooling tower make-up line. The tank, located east of the induced draft fans, rests on a selected fill foundation inside a concrete ring, 24.0 cubic yards, placed August 30 and September 13, 1961. American Steel and Iron Works, Incorporated, fabricated the 40'-0" inside diameter by 28 feet high tank on Order NY-771912. Erection of the tank was performed by Taylor Construction Company for the vendor. The tank was turned over to the operating department on Equipment Turnover Record, Sheet No. 87, dated June 22, 1962.

Water for the high pressure ash water pumps is delivered from the tank through a 24 inch concrete conduit installed under ground. The pumps are mounted on concrete foundations, 5.5 cubic yards, placed October 25, 1961, located east of the ash hopper near Column "Ha-13". C H Wheeler Manufacturing Company furnished two (2) pumps, Order NY-771902, each which supply 1600 gpm water at 315 foot head to the three (3) jet pumps, the hydraulic ejectors for the dry ash system, and ash hopper nozzles. The pumps were turned over to the operating department on Equipment Turnover Record, Sheet No. 82 (No. 1) and 83 (No. 2), dated June 22, 1962.

An air separator is provided in the dry ash system after the ash has been pulled by the ejectors. Excess water from the air separator is routed to the sump in the ash hopper area. Overflow water from the ash hopper and water from the furnace seal box, at the connection of the furnace and the ash hopper, is also collected in the sump. Two (2) vertical sump pumps, 250 gpm at 90 foot head, furnished by Allen-Sherman-Hoff Company on Order NY-771910, discharge the water through a four (4) inch steel pipe to the ash settling basin.

A reinforced concrete trench containing 245 cubic yards, was constructed from the station building east to the railroad tracks and northeast to clear all the coal storage tracks. Concrete placements were started on November 11, 1961, and completed June 14, 1962. Wooden bents constructed of treated wood were provided to carry the ash disposal pipe overhead from the pipe trench north approximately 1,700 feet to the settling basins.

Ash collecting piping from all the hoppers, discharge piping from jet pumps and ejectors and overflow piping from the

air separator and ash hoppers was furnished by United Conveyor on their Order NY-771900. The ash water collecting piping, emergency fill line, sump pump discharge, and high pressure water to jet pumps, ejectors and hoppers were furnished and fabricated by Midwest Piping on Order NY-771889. American Cast Iron Pipe Company supplied the special alloy cast iron ash discharge pipe on Order NY-771939. All of the above piping was installed by B F Shaw Company on their piping erection contract. The 24 inch concrete supply pipe from the storage tank to the ash water pumps was purchased from Coppco on Order 3C-439 and installed with our pipefitter forces. The ash handling system was turned over to the operating department on Equipment Turnover Record, Sheet No. 81, dated June 22, 1962.

Pulverized Coal Equipment

Riley Stoker Corporation furnished four (4) No. 556 E duplex pulverizers. Order NY-771816, each having a maximum continuous capacity of 37,000 pounds per hour and a range of 8:1 coal of 3/4 inch size pulverized to 70 per cent fineness through a 200 mesh screen and 99 per cent through a 50 mesh screen. Also included are eight (8) drum type coal feeders with revolution counter and drive connections. The primary air duct from the hot air duct at the boiler front to the mills was furnished with the mills and erected by boilermakers. The burners and coal feeder piping from the mills to the burners were furnished and installed by Babcock and Wilcox Company as part of the boiler order, NY-771802. Insulation on the feeder pipes was by Insulation Services, Incorporated, on Order NY-771932.

Sixteen (16) drilled cassions to support the foundations were constructed by Meredith Drilling Company on Order 3C-9 and utilized 18.5 cubic yards of concrete. Excavation for the foundations in shale and sandstone was accomplished by use of a Bucyrus Erie [illegible] cubic yard backhoe and final alignment and grading air driven hand tools. Excavation was neat line to eliminate forming and excavation. Concrete, 179 cubic yards, was placed between December 8, 1960, and April 18, 1961, with actual placements recorded on construction progress drawing 3C-P-7, "Equipment Foundations," included elsewhere in this report. A change in design of the mill bases after the concrete was placed necessitated the addition of anchor bolts and the foundations were revised accordingly at the vendors expense.

Tests on mills in existing units proved the mill design inadequate for required results in fineness and maximum output. Fabrication of our mills was delayed until test results from some proto-type mills developed for use by an eastern utility company were available. The results indicated alterations in mill size and design. Fabrication was, subsequently, started very late in the construction schedule. In order to maintain the construction schedule for other phases of the project, the building was closed in and a minimum of access space for installation of the mills was available. The tops had to be removed and caused additional cost for installation. Riley Stoker Corporation made further revisions in the classifier and internals

prior to placing the mills in operation. The first mill was received December 18, 1961, and the last mill was received January 3, 1962.

During initial operation of the pulverizers, the motor tripped out after about 50 seconds of operation and on subsequent starts, the driver tripped out in less time. It was found that the Rawson coupling shoes were locked due to the shoe material being too soft. Riley substituted a hard cast iron material for the shoes and subsequent startups were satisfactory. On May 16, 1962, a preliminary performance check was made on pulverizer 3C and the mill performed at the rated capacity with good fineness results; however, power requirements were notably higher. Inasmuch as this is the first production model of a Riley pulverizer with the new internal by-pass classifier, it was determined that the fan was constructed with too great a diameter, and was requiring additional power for operation. The fans were revised during July of 1962, and performed satisfactory.

Another feature of the new type pulverizer which caused some trouble was the coal feeder tramp iron chutes. The principal of using hot primary air introduced through a bleeder line into the chute near the top to prevent fine coal carryover failed to function properly and the chute filled in about ten minutes. Subsequently, fire developed within a reasonably short time when the mixture of fine coal, iron pyrite and hot air was allowed to remain in stagnation. Riley resolved this problem by increasing the amount of bleed air and drilling holes in the tramp iron chutes which served to temper the primary air.

The mills are located on the ground floor, Elevation 5130.0', immediately below the coal silos and are driven by motors supplied by Westinghouse Electric Corporation on Order NY-771813. Insulation and lagging, including installation for their section of the primary air duct, were included in Riley Stoker Company's Order NY-771817. Insulation Services, Incorporated, furnished the lagging and applied the insulation for Riley Stoker Corporation as a subcontractor. Pulverizer equipment was turned over to the operating department on Equipment Turnover Record, Sheets Nos. 52, 53, 54 and 55 dated June 22, 1962.

Forced Draft Equipment

Combustion air is supplied by two (2) forced draft fans located under the air heaters between column line "14" on the north, column line "12" on the south, column line "Ha" on the west and column line "Ja" on the east. An enclosure of galvanized screen wire supported by structural framing on three sides of the perimeter prevents debris from being sucked into the fans. The Sturtevant double inlet fans with inlet vanes and outlet dampers are designed to deliver 795,000 pounds per hour at a static pressure of 13.4 inches of water and were supplied by Westinghouse Electric Corporation, Sturtevant

Division, for Babcock and Wilcox Company on Order NY-771802. Motors for the fans were furnished by Westinghouse Electric Corporation on Order NY-771813.

Air from the fans is conveyed by duct work to the two (2) Ljungstrom vertically mounted regenerative type air heaters. Steam coil type preheaters are installed in the air duct ahead of the air heaters. Hot air leaving the air heaters is routed thru ductwork to the burner windbox at the front of the furnace by air ducts running horizontally along the north and south faces of the boiler at Elevation 5171'-0", approximately. Air ducts were insulated by Insulation Specialties, Incorporated, and lagged with .032 inches thick aluminum by Jamar-Olman Company under the boiler contract.

Concrete foundations for the fans are each supported by four (4) eighteen inch diameter cassions drilled into the underlying shale. Meredith Drilling Company drilled and concreted (11.5 cubic yards), the cassions between June 21, and June 24, 1960, on Order 3C-9. Concrete for fan 3A foundation, (28 cubic yards), was placed on March 15, and April 4, and for fan 3B foundation, (27.5 cubic yards), on April 4, and April 12, with actual placements recorded on Construction Progress Drawing 3C-P-7, "Equipment Foundations", included elsewhere in this report.

Fans were set on their foundations April 19, 1961, and grouted on June 2, 1961. Testing of the fans was accomplished prior to boil-out and the fans were turned over to the operating department on Equipment Turnover Record, Sheets No. 10 and No. 11, dated March 12, 1962.

Fuel Gas Equipment

Initial design of the Unit No. 3 called for gas to be supplied to the pilot ignitors only with a small regulating station at the southeast corner of the boiler. Pilot ignitors and all associated accessories were supplied with the boiler by Babcock and Wilcox Company on Order NY-771802. Lighter gas piping within the building was fabricated by Midwest Piping and Supply Company on Order NY-771889, and installed by B F Shaw Company on their order, 3C-147. Electrical equipment was installed by the electrical contractor, Sturgeon Electric Company.

In the late stages of construction, the fuel requirements were revised to incorporate using fuel gas on four (4) of the sixteen (16) main burners. The four (4) burners to be revised were the lower row at the operating floor level. The revisions to the burners were supplied and installed by Babcock and Wilcox Company on a supplement to their order. Main gas piping within the building was sized to be adequate for the addition of twelve (12) burners in the future, or a total of sixteen (16) and was fabricated by Midwest Piping and Supply Company on a supplement to their Order NY-771889. The main gas valve was supplied by Rockwell Manufacturing Company on

Order NY-771940 and the regulator by Bailey Meter Company on Order NY-771834. Main gas piping and all appurtenances were installed by our pipefitter forces.

A temporary 6 inch gas line was run parallel to the 4 inch igniter gas line from the existing regulating station to the rear of the boiler. It is proposed to bring in a new gas main with its own regulating station when Unit No. 3 is converted to dual fuel burning.

Boiler Equipment

Excavation for main boiler column foundations was started June 13, 1960, using a D-8 bulldozer, a D-6 front end loader and dump trucks and approximately 1375 cubic yards were removed by August 10, 1960. Eighteen (18) caissons were augur drilled into shale by Meredith Drilling Company on Order 3C-9, and included 202.5 cubic yards of concrete. A typical cross-section of the soil formations is shown on Drawing SK-7988-F32, "Sub-Surface Profiles", included elsewhere in this report. Excavation for caissons caps was accomplished by use of a one (1) cubic yard Bucyrus Erie backhoe rented from Gil Clark on Order 3C-27. Concrete placement for the caisson caps and piers (152.5 cubic yards) was started on July 25, 1960, and completed on September 9, 1960. Concrete for grade beams, (28 cubic yards), was placed intermittently from August 31, 1961, to December 8, 1961. Actual concrete placements are recorded on Construction Progress Drawings 3C-P-1, "Caisson Data As-Built", 3C-P-2, "Sub-Structure Foundations", and 3C-P-3, "Slabs and Grade Beams - Elevation 5130", all included in the drawing section of this report.

Structural steel for the boiler was furnished with the boiler on Order NY-771802. Initial shipments of steel were received on August 16, 1960; however, actual erection did not start until December 12, 1960, as the fabricating and shipping sequences were not correlated to the erection sequence. After the one month delay in starting erection, good progress enabled the contractor to complete erection in line with his schedule. The field contract, 3C-150, for boiler installation with Babcock and Wilcox Company included erection of the 666 tons of high strength bolted main steel and 91 tons of miscellaneous steel including stairs, platforms, handrails and grating.

Ground floor slabs in the boiler area were compacted dirt backfill in the forced draft fan room and 52 cubic yards of sand cement fill around the ash hopper areas. Concrete placements for the ground floor slab (93.75) cubic yards) were started on October 27, 1961, and completed on March 8, 1962, with placement dates recorded on Construction Progress Drawing 3C-P-8, "Slabs and Grade Beams - Elevation 5130", located elsewhere in this report.

Superstructure floors were steel grating except in the enclosures around the steam drum ends which were steel

checkered plate. A reinforced concrete slab containing 16 cubic yards was placed May 24, 1961, which acted as an access platform around the Ljungstrom air heaters and a roof over the forced draft fan room.

A reinforced concrete slab was placed June 14, 1961, at Elevation 5187.5' over the upper firing aisle containing 13.5 cubic yards and recorded on Construction Progress Drawings 3C-P-10, "Floors and Roofs - Sheet No. 2, included elsewhere in this report. Flexicore precast concrete slabs were supplied for the operating floor, Elevation 5155.0, platforms along the sides of the boiler and the roof section over the forced draft room. A three (3) ply membrane waterproofing or a 20-year bonded built-up roof were applied over the concrete and Flexicore precast slabs by Bacon and Schramm on Order 3C-146. Concrete wearing surfaces, (38.5 cubic yards), were placed over the membrane for the firing aisle roof, and the Elevation 5155.0' operating floor boiler platforms and roof. Actual placement dates are recorded on Construction Progress Drawings 3C-P-10, "Floors and Roofs - Sheet No. 2" and 3C-P-11, "Floors and Roofs - Sheet No. 3", included in the drawing section of this report.

A protective enclosure is provided around the north and south ends of the main steam drum. Steel framing, floor and roof plates were furnished by Denver Steel and Iron Company on Order 3C-422, corrugated asbestos cement siding was supplied by Corrugated Asbestos Contractors on Order NY-771904, the 10 kw electric unit heaters by Oliver and McClellan, Incorporated, on Order NY-771925, doors by Richmond Door and Specialties on Order NY-771917, exhaust fans by A F Hinrichsen, Incorporated, on Order NY-771926 and motor operated louvers and dampers by the Airolite Company on Order NY-771934. Erection of all components was accomplished with our forces except for the heating and ventilating equipment which was installed by the heating and ventilating contractor.

The steam generating unit is a Babcock and Wilcox Company, Order NY-771802, reheat, radiant, single drum, divided furnace, front fired, semi-outdoor type, capable of continuously delivering 1,140,000 lb/hr of steam with a superheater outlet pressure of 1925 psig at 1000 degrees F, with reheat temperature of 1000 degrees F, when using Routt County bituminous coal as the primary fuel. A secondary fuel, natural gas, is provided for only four (4) of the sixteen (16) burners at this time with provisions to convert the other twelve (12) in the future. The steam generator has all of the usual accessories except coal pulverizing equipment, previously described, and consists of single pass Ljungstrom air heaters, forced draft, induced draft and recirculating fans, dust collector with hoppers, air ducts, gas flues, combination coal and gas burners and a soot blowing system all suitable for outdoor installation. A complete steam temperature control system consists of three (3) elements, namely, gas recirculation, dampers, and spray desuperheaters for emergency use only. Forced and induced draft fans supply air required for combustion and removal of products of combustion over entire range of output up to, and including

maximum specified conditions, and are designed to provide minimum margin of 5 per cent on capacity and 32 per cent on pressure. Also included are superintendence of erection, complete erection of brick work and installation of insulation with its sheet metal lagging.

Feedwater heated to 500 degrees F enters the economizer, 14,200 square feet of heating surface, and after additional heating, enters the drum. After the water is heated in the furnace tubes to saturated temperature, it is flashed to steam in the drum. The steam passes from the drum to the primary and secondary superheaters with a total of 11,963 square feet of heating surface of pendent type non-drainable tubes where the temperature is raised to 1005 degrees F at a pressure of 1900 psig.

After the steam has passed through the high pressure turbine, part of the steam, 933,000 pounds per hour, is returned to the boiler reheater at 666 degrees F and a pressure of 474 psig for additional heating. In the reheater, 23,806 square feet of heating surface, the temperature is raised to 1005 degrees F at a pressure of 450 psig and routed to the intermediate pressure turbine for reuse.

In order to assist construction supervisors and workmen to visualize the various components of the boiler and their relation to each other for sequence of erection, the engineering department of Public Service Company of Colorado contracted with Air-Vu Company, Incorporated, to make a sectionalized "Aerial-Vu" projection of the steam-generator with its accessory equipment. This projection depicts in scale an angle aerial view of the complete steam generator with all its accessory equipment sectionalized in detail and located in their true relation with each other. To make this projection, many of the components were detailed on separate drawings, several of which were assigned field drawing numbers. These projections are then turned over to the operating department for their use in helping new operators to visualize not only the details of the various equipment, but also follow the flow of the various systems and their relation to each other. The following list of drawings are included in the drawing section of this report:

Sectionalized "Aerial-Vu" Projection - B & W Radiant Reheat Boiler
SK-7988-F6, Arrangement of Furnace Supply and Riser Tubes
SK-7988-F7, Arrangement of Furnace Headers and Wall Tubes
SK-7988-F8, Arrangement of Convection Pass and Saturated Furnace Roof Tubes
SK-7988-F9, Arrangement of Primary, Secondary Superheat and Reheat Headers and Tubes

Babcock and Wilcox Company having just opened a district office in Denver, and the new district representatives to establish themselves, made such an attractive firm price bid to install the complete boiler including all the material furnished under their purchase order, they were awarded a contract,

30-150, for erection of the boiler. An existing temporary railroad spur utilized for Unit No. 2 construction, was rerouted and run into the boiler area to facilitate erection. Unloading and storage of material were accomplished by use of a ten (10) ton American diesel locomotive crane equipped with a 60 foot boom and 10 foot jib. This crane with flatcars was also utilized for reloading and hauling material from storage areas to the erection area. A 20 ton motorcrane was also utilized for "shaking out" and hauling structural steel from the storage areas. Erection of structural steel was accomplished by use of a one-hundred (100) ton Model 3900 Manitowac crawler crane equipped with 160 foot boom and a 30 foot jib of 10 ton capacity.

Prefabrication of the two (2) convection pass sidewall panels was started by welding up components on the ground on January 3, 1961. Castable refractory was applied to the above panels and they were erected with the main steel second tier on January 27. Erection of the hangers, upper water wall headers, attemporator piping and downcomers was started on February 13, 1961, simultaneous with steel erection sequence. Panelizing of furnace water wall tubes including buckstays on the ground prior to erection was prosecuted to the greatest extent possible thereby minimizing erection of scaffolds and eliminating costly welding procedures in the air.

The main steam drum is 52'-2-1/2" long, with an inside diameter of 66 inches and a thickness of 5-3/4 inches and weighing 149 tons. Special lifting supports of built-up structural members were furnished by Babcock and Wilcox Company along with special hoists and blocks. Rigging consisted of two (2) single drum draw works, each having a capacity of 20,000 lbs, with one (1) inch cable reeved to 17 parts through 200 ton blocks. The drum was received on February 22, 1961, and raised to position on February 24. Erection was witnessed by Public Service Company of Colorado officials and management, also coverage by the local television and newspaper reporters for publicity in their respective mediums.

The divided furnace section is enclosed by steam generation tubes with water supplied from the drum to headers by 42 supply tubes, 6-5/8 inches outside diameter at the furnace bottom by means of three (3) downcomers, 22 inches inside diameter. Water heated to saturated temperature in the generation tubes returns to the drum from headers, at the top of the furnace, through 57 riser tubes, 6-5/8 inches outside diameter, and is flashed to steam. All components are of welded construction. Due to the length of generation tubes, 107'-4" long, it was necessary to fabricate the components in at least two sections with considerable welding at these joints.

There are a total of 5888 welds in the complete boiler including superheater, reheater and economizer. Babcock and Wilcox Company qualified all their welders on the project under the direction of the erector and in accordance with their welding procedure. Twenty-two (22) operators were tested with

eighteen (18) qualified and four (4) failures. Major welds in large diameter heavy wall sections were preheated, stress relieved and radiographed.

The boiler is encased in a 10 guage steel casing seal welded on all seams. The boiler was air tested to a pressure of three (3) inches of water with satisfactory results on November 17, 1961. Preparations for this test included blanking gas ducts at the rear of the boiler, approximately Elevation 5130.0, installation of plumbers expansion plugs in all soot blower openings, blanking coal piping near the burners and filling the water seal trough between the boiler and ash hopper.

Preparations for the hydrostatic test were started early in December, 1961, but were delayed due to an unusual below zero cold wave. Preparations were resumed on December 14, 1961, when filling the boiler with water revealed several tube leaks in the rear furnace wall which were repaired. The test was again delayed on December 19, when the Hartford Boiler Inspector would not accept a hydrostatic test until the welds on the main steam pipe were stress relieved, reversing previous understandings. Stress relieving of the main steam welds was completed December 27, and due to the cold weather and the holidays, the filling of the boiler was again postponed. The boiler was filled with water on January 4, 1962, and when pressure was placed on the boiler, additional leaks were detected and repaired. The hydrostatic test at 3225 psig, was finally realized on January 5, using an American Marsh size 10 x 1 x 12 air driven pump and inspected by a representative of Hartford Steam Boiler Insurance Company. The reheater was hydrostatically tested to 900 psig on January 19, 1962.

The air heater consists of two (2) Ljungstrom regenerative type, Air Preheater Corporation manufacture, vertical shaft, revolving heating element, encased in an air tight steel casing with heat insulation and aluminum metal lagging suitable for outdoor installation, arranged at the rear of the boiler. Flue gases at 1200 plus degrees F from the boiler convection pass area enters, thru connecting ductwork, the two (2) single pass, 114,500 square feet heating surface each, and heats combustion air from the forced draft fans. Each heater is equipped with its own driver, lubrication system and air cleaning device. Four (4) finned type steam coils are installed in the cold air duct before the air heater to preheat the air and maintain the temperature above the dew point. This eliminates the possibility of moisture collecting on the air heater elements with subsequent damage.

Erection of air heaters was started on February 1, 1961, with the assembly of rotor and housing sections on the ground. The particular arrangement at the rear of the boiler allowed the contractor to completely weld the sections together and set the housing and shell as completed units using the 100 ton Manitowoc crane. Air heater 3B was set in position on

February 10, and 3A was set on February 21, 1961. Basket-type elements were packed in the rotors after they were set in place. Steam coil air preheaters were installed in the forced draft fan discharge duct and erected with the duct on April 24, 1961.

A sequential system of electrically operated soot blowers are Diamond Specialty manufacture consisting of a control panel, soot blowers for the boiler, air heaters and gas recirculating fans, piping on the boiler to all blowing units, motor starters with disconnect switches in weatherproof cabinets and a dual pressure type air reducing station, furnished by Babcock and Wilcox. Soot blowers are arranged in pairs, one on each side of the boiler and opposite to each other on the water walls. Thirty-two (32) Model IR soot blowers are used to clean furnace water wall tubes. Four (4) Type IK retractable soot blowers are used to clean the secondary superheater elements, the primary superheater elements are served by six (6) and the reheater elements are served by eight (8).

The boiler including air heaters and soot blowing system were turned over to the operating department on Equipment Turnover Record, Sheet No. 51, dated June 22, 1962.

High pressure air for soot blowing is provided by three (3) duplex, three stage, horizontal, 600 cfm air compressors supplied with aftercoolers, silencers, and filters by Ingersoll-Rand Company on Order NY-771824. Motor drivers, 200 hp, for the compressors were supplied by Westinghouse Electric Corporation on Order NY-771813. They are located in an area bounded by column line "10" on the south, column line "11" on the north, column line "Da" on the west and column line "Gb" on the east, at the ground floor, Elevation 5130.

Initial planning was for two (2) compressors to serve Unit No. 3; however, shortage of air for Units No. 1 and No. 2 necessitated addition of a third compressor to augment the present systems. Compressor No. 7 was rushed to completion, tested and turned over to the operating department on Equipment Turnover Record, Sheet No. 3, dated September 15, 1961. The two (2) remaining compressors, No. 6 and No. 8, were turned over to the operating department on Equipment Turnover Record, Sheets No. 64 and No. 65, dated June 22, 1962.

Thirteen (13) cassions drilled into the shale containing 26 cubic yards of reinforced concrete were constructed for the soot blowing air compressor foundations by Meredith Drilling Company on their contract, 3C-9, with actual placement dates recorded on Construction Progress Drawing 3C-P-1, "Caisson As-Built Data", included elsewhere in this report. Concrete for the foundations containing 60 cubic yards was placed between November 28, 1960, and May 22, 1961, with actual placement dates recorded on Construction Progress Drawing 3C-P-7, "Equipment Foundations", included elsewhere in this report.

Pittsburgh-Des Moines Steel Company supplied a 1000 cubic foot vertical air receiver for the soot blowing system on

Order NY-771871. The receiver is mounted on a concrete foundation, 3.5 cubic yards, placed July 7, 1961, located outside the building near column "Gb-12."

Boiler Plant Auxiliaries

The boiler feedwater heating cycle consists of seven (7) feedwater heaters and one (1) closed deaerating heater. All feedwater heaters are shell removing type with welded feedwater and extraction connections except the 18th stage heater, which is a tube bundle removing type and has flanged feedwater connections. The alternate arrangement of the 18th stage heater was necessitated by its location in the neck section of the condenser. The flow cycle of the feedwater starts in the condenser hotwell thence through the condensate pumps, low pressure heaters and into the deaerator. The cycle continues from the deaerator, through the boiler feed pumps, high pressure heaters, boiler economizer and into the boiler steam drum. The deaerator and its storage tank are set at an elevation based on the Hydraulic Institute recommendation plus a static head margin. The flow diagram is shown as part of the main systems on Ebasco Drawing G-159627, "Flow Diagram - Main Systems". It is also depicted on an "Aerial View" projection, included elsewhere in this report. The boiler feed piping system was hydrostatically tested to 4250 psig, March 2, 1962, flushed out March 5 and turned over to the operating department on March 13, 1962, by Equipment Turnover Record, Sheet No. 21.

The four (4) high pressure feedwater heaters are Yuba, Multilok type, U-tube design, two pass tubes, three pass shell, horizontally mounted, single flow and contain desuperheating, condensing and subcooling drain sections. Drains are controlled automatically to cascade from the higher pressure heater to the next lower pressure heater, with provisions to bypass that heater when it is out of service and cascade to the next lower pressure heater. Seperate vents are routed to the deaerator. Normal flow of high pressure heater drains is to the deaerator, with an emergency drain provided to the condenser during low loads. Flow to either point is controlled automatically with a split range level controller located on the 12th stage heater.

Two (2) low pressure feedwater heaters are Yuba, bolted head type, U-tube design, two-pass tubes, two-pass shell, horizontally mounted, single flow with condensing and subcooling sections. One (1) low pressure feedwater heater is a Yuba, bolted head type, U-tube design, two-pass tubes, one-pass shell, mounted in the condenser neck, single flow with condensing section only. The low pressure heater drains are collected in a drip pot and then pumped back into the feedwater system before it enters the 12th stage heater. An emergency dump is provided directly to the condenser. Seperate vents for the low pressure heater are routed to the condenser.

Three half capacity Allis Chalmers boiler feed pumps, 625,000 pounds per hour at 293 degrees F (two operating) are

provided with automatic recirculation control and conventional feedwater regulating valve for drum level control. Water supply for the feedwater pumps is from the 265,000 pound water storage tank furnished with the deaerator. This provides for a 12 minute storage at design load. Recirculation from the feed pumps is broken down by use of high pressure breakdown orifices and discharges into the deaerator.

Make-up water for the feedwater system is provided by flashing raw water to steam in a vertical, stainless steel spray tray type preheater with external vent condenser capable of deaerating 35,040 pounds per hour of treated water. Heat for the evaporator is supplied by extraction steam from the 12th stage of the turbine and alternately by reduced saturated steam from the auxiliary steam station supplied from the superheater intermediate header of the boiler. Continuous blowdown from the boiler is routed to the evaporator preheater in order to utilize otherwise wasted heat. Evaporator vapor is run to the 14th stage extraction line and thence to the deaerator. Drip from the evaporator coils is collected in a drain receiver and then dumped into the condenser hotwell. Continuous blowdown from the evaporator flows into a flash pipe and then continues to waste.

There are four (4) high pressure extraction heaters located in an area bounded by column line "B" on the west, "D" on the east, "12" on the north, and "10" on the south with the centerline of heaters located at Elevation 5175.0. From south to north, the heaters use extraction steam from the high pressure turbine 4th, 7th, 10th and 12th stages respectively for feedwater heating. They were turned over to the operating department on Equipment Turnover Record, Sheet Nos. 57, 58, 59 and 60 dated June 22, 1962.

Steam from the 14th stage is used for deaerating and feedwater heating in the deaerator, which is located on column line "C" between columns "10" and "12" with the centerline at Elevation 5203. The feedwater storage tank is directly below the deaerator with its centerline at Elevation 5191.75. They were turned over to the operating department on Equipment Turnover Record, Sheet No. 56 dated June 22, 1962.

Two low pressure heaters are located in a heater and evaporator bay bounded by the same columns as the high pressure heater bay but on the next lower floor, Elevation 5155.0. Centerline of the heaters is Elevation 5158.5. From south to north, the heaters use extraction steam from the 16th and 17th stages of the turbine for feedwater heating. One low pressure heater is located in the condenser dome section at Elevation 5148.08 and utilizes steam from the 18th stage of the turbine. The three (3) heaters were turned over to the operating department on Equipment Turnover Record, Sheet Nos. 61, 62 and 63 dated June 22, 1962.

All feedwater heaters were furnished by the Yuba Consolidated Industries Corporation on Order NY-771819. Graver

Water Conditioning Company furnished the deaerator and storage tank on Order NY-771818. The storage tank and the deaerator were set January 8, 1961, during structural steel erection. A special cradle was designed and fabricated at the jobsite to facilitate the setting of the six (6) feedwater heaters located in the heater bays. Heaters were loaded on our flatcar and brought into the station building unloading bay with the plant diesel locomotive, raised to Elevation 5155 by the station gantry crane and placed on the cradle. Then the station crane raised cradle and heater to the heater bay Elevation 5172, where they were rolled into position using the shell removing wheels of each individual heater. The fourth stage heater was set May 26, 1961, the seventh stage, May 25, the tenth stage, June 1, the twelfth stage May 31, the sixteenth stage June 2, the seventeenth stage June 2, and the eighteenth stage heater was installed in the condenser dome section March 15, 1961. Our piping forces set and trimmed the feedwater heaters as well as all other heaters, vessels, pumps, and related equipment. Heat insulation and .020 aluminum lagging were furnished and applied by Insulation Services, Incorporated, on Order NY-771932.

The evaporator and preheater were supplied by Griscom-Russell Company on Order NY-771825. The evaporator is horizontally mounted on the operating floor with its centerline at Elevation 5160 and located between columns "B" and "D" and "10" and "11". The preheater is vertically mounted on the Elevation 5171 floor above the evaporator. The evaporator was set June 8, 1961, and the preheater June 7, and they were turned over to the operating department on Equipment Turnover Record, Sheet No. 66 and No. 67 dated June 22, 1962.

The evaporator drip pot is vertically mounted with its centerline at Elevation 5141 and is located nine and a half (9-1/2) feet north of column "12" and two (2) feet west of column "B". The evaporator flash pipe is located three (3) feet, nine (9) inches north of the evaporator with its centerline at Elevation 5165.5. The drip pot and blowdown pipe were furnished by Midwest Piping Company on Order NY-771889 and erected by B F Shaw on field contract, Order 3C-147.

Three (3) boiler feed pumps each capable of delivering 625,000 pounds per hour of 293 degree F water were furnished by the Allis Chalmers Manufacturing Company on Order NY-771804. A spare rotating element was also provided on this order and turned over to the operating department on Equipment Turnover Record, Sheet No. 2, dated February 9, 1961. Drivers for the pumps are 2250 hp electric motors furnished by Westinghouse Electric Corporation on Order NY-771813. The pumps are located in an area bounded by column line "12" on the north, "10" on the south, "D" on the east, and "B" on the west with centerline of pump shaft at Elevation 5134. The pumps were set on their foundations by our pipefitter forces; the motors were set by Sturgeon Electric Company under their electrical contract; the coupling, alignment and grouting (11.5 cubic yards placed May 8, 1961) were accomplished by our millwright forces; and

the thermal insulation was applied by Insulation Services Incorporated on their order NY-771932. Pump 3A was tested March 2, pump 3B March 6, and pump 3C March 8, 1962. All pumps were turned over to the operating forces on March 12, 1962, by Equipment Turnover Record, Sheet Nos. 7, 8 and 9 respectively.

The boiler feed pump foundations are reinforced concrete supported by reinforced concrete caissons drilled into the underlying shale. The 3A foundation is symmetric and supported on four (4) eighteen (18) inch caissons; the 3B and 3C foundations are not symmetric or opposite hand, their shape dictated by adjacent building foundations. The 3B foundation is supported by two (2), twenty-four (24) inch and one (1), forty-two (42) inch caissons and the 3C foundation is supported by two (2), twenty-four (24) inch and one (1), thirty-six (36) inch caissons. The caissons were drilled during June and July, 1960, and the foundations contained 71-1/2 cubic yards of class "B" concrete which was placed September 28, 1960, as recorded on Construction Progress Drawing 3C-P-7, "Equipment Foundations", included elsewhere in this report.

Midwest Piping and Supply furnished the low pressure drain receiver and it was set by B F Shaw Company on their respective general fabrication and erection piping contracts. The two (2) low pressure drip pumps, furnished by Goulds Pumps Incorporated on Order NY-771837, are mounted on an eighteen (18) inch deep plain concrete foundation resting on the sand cement fill below the ground floor slab end contain two (2) cubic yards of concrete placed March 27, 1961. They are located on column line "14" between column lines "A" and "B" under the turbine generator pedestal at Elevation 5130. Motor drivers for the pumps were supplied by Westinghouse Electric Corporation on Order NY-771813. Trial operation of the pumps was realized on May 17, 1962, and they were turned over to the operating forces June 22, 1962, by Equipment Turnover Record, Sheets No. 71 and No. 72.

The Ph on feedwater is controlled by injecting phosphate, sulphite and/or morphaline into the feedwater system. Phosphate is injected into the steam drum while sulphite and morphaline are injected into the feedwater system downstream from the reheat and superheat desuperheating water station takeoff near the 12th stage heater. Milton Roy Company furnished the pumps with their motors and mixing and storage tanks on Order NY-771866. The chemical feed equipment is located in an area bounded by columns "Fa" and "Gb" "14-1/2" and "15" at Elevation 5130, except the mixing tank which is located in the same area but on the mezzanine floor above at Elevation 5142. The chemical feed system was initially operated April 27, 1962, and was turned over to the operating department on June 22, 1962, by Equipment Turnover Record Sheet No. 78.

Ingersol-Rand Company furnished the evaporator feed pump to supply raw softened water to the evaporator on Order NY-771843. The 7-1/2 hp motor was furnished by Westinghouse

Electric Corporation on Order NY-771813. The evaporator feed pump is located adjacent to, and north of Units No. 1 and No. 2 pumps and is seven (7) feet east and seven (7) feet north of column "E-6" at Elevation 5130. The pump was set early in June and was grouted June 21, 1961. It was test run June 9, 1962, and turned over to the operating department on June 22, 1962, by Equipment Turnover Record, Sheet No. 73.

Feedwater flow to the boiler is regulated by a control valve in the boiler feed discharge line upstream from the 12th stage high pressure feedwater heater. Regulation is automatic during normal operating sequences and is controlled by the water-steam ratio in the steam drum. A manual remote motor operated valve is provided for control of feedwater flow in the event the regulator valve is out of service, or during startup when load is too low for automatic operation. The regulator valve located at Elevation 5155 near column "C-12" was furnished by Bailey Meter Company on Order NY-771854.

Blowdown from the boiler and evaporator is flashed in a blowdown pipe near column "Fa-12" at Elevation 5130. Drains from all boiler headers are routed to this tank which has a twelve (12) inch vent that extends above the top of the boiler support steel and a six (6) inch drain which extends to the yard drainage system. The tank is supported by a reinforced concrete foundation, two (2) cubic yards, which was placed on April 4, 1961. Midwest Piping and Supply Company fabricated the blowdown tank on Order NY-771889 and it was installed by B F Shaw Company on their field contract, Order 3C-147.

A free blow tank was provided to expand steam from drains of certain piping systems. Included in these systems are trap drains from the auxiliary steam regulating station, air heater coil steam feed regulating station and main steam drain and warm-up connections. The tank is located on the mezzanine floor, Elevation 5138.5', four (4) feet east and eleven (11) feet north of column "B-11". An eight inch vent from the tank extends upward to tie into a ten (10) inch vent from other equipment at Elevation 5157' and then extends above the tripper floor to terminate at Elevation 5218. The drip discharges through a three (3) inch line to the low pressure drain header at the condenser. Midwest Piping and Supply Company furnished the free blow tank on Order NY-771889 and it was installed by the B F Shaw Company on their field contract, 3C-147. Heat insulation and aluminum lagging were furnished and installed by Insulation Services on Order NY-771932.

A boiler-turbine-generator control board and auxiliary panel is installed in the control room for instrumentation and control of boiler, turbine, generator and auxiliaries. It is a functional, tunnel type board with a vertical rear panel and a combination console vertical face front. Instruments on the panels are fed electrically or pneumatically and provide the necessary information on the various components of plant equipment to realize continuous plant operation. Westinghouse

Electric Corporation furnished the board with accessory items such as internal wiring, pneumatic tubing, indicating lights, pushbuttons, relays, annunciators, terminal blocks, indicators for electrical functions of generator, exciter, main transformer and auxiliary motors, synchroscope and control switches on Order NY-771811. The board is arranged diagrammatically so that from the board an operator may determine the electrical interlocks connected with each system and what conditions are necessary for proper operation. A malfunction or failure of any equipment will actuate the annunciator panel at the top of the board and the operator can take remedial measures.

Instruments mounted on the BTG control board furnished by other vendors are: Bailey Meter Company, NY-771854, recorders, indicators, combustion and feedwater control selector switches; General Electric Company, NY-771801, indicators; Babcock and Wilcox Company, NY-771802, steam temperature control selector switches and recorders; Manning, Maxwell and Moore, NY-771856, pressure receivers; Fischer Porter Company, NY-771830, operations recorder; Leeds and Northrup Corporation, NY-771901, recorders; Foxboro Company, NY-771858, miniature recorders; and Republic Flow Meters Company, NY-771853, draft gages.

Piping for instrumentation and control was purchased locally and installed by Ebasco piping forces. Included in this classification are the control air supply piping consisting of copper tubing and multi-conductor armor covered tubing to the locally mounted controls and relay piping from transmitters to panel mounted indicators. All piping systems for control and instrumentation are field run from a specific control or tap point to specifically located panels. High pressure taps from such items as the boiler feed, boiler and gas systems are run in high pressure lines to a Boiler Gage Panel located north of the control room near column "C-14" at Elevation 5155'. From this point, multitube is run to a relay rack located in the cable enclosure room northeast of column "C-14" at Elevation 5142'. Pressure lines from other piping systems or auxiliaries also come into this rack and all lines then run in multitube to instruments on the boiler-turbine-generator control board. The Boiler Gage Panel was furnished by Panellit, Incorporated, on Order NY-771896, and the relay rack was furnished by Bailey Meter Company on Order NY-771854, with relays and stanatrols mounted, but not tubed. Tubing of the relay rack was performed by our pipefitter forces at the jobsite.

A closed circuit television was provided for visual check on boiler drum water level by Diamond Power Specialty Corporation on Order NY-771860. The camera and control unit are mounted adjacent to the north drum water column at Elevation 5251.85. Monitors are located on the B T G board and at the feedwater regulating station for visual water-steam ratio in the steam drum.

Locally mounted instruments, meters, thermometers and gages include: pressure indicators supplied by Manning, Maxwell and Moore, Incorporated on Order NY-771856; temperature indicators

supplied by Manning, Maxwell and Moore Incorporated on Order NY-771859; transmitters furnished by Bailey Meter Company on Order NY-771854; conductivity cells and Larson Lane steam analyzers supplied by Leeds and Northrup Company on Order NY-771901; water level gages furnished by Yarnall-Waring Company on Order NY-771897; differential pressure switches furnished by Barton Instrument Company on Order NY-771922; and drum level and pressure gages supplied by Babcock and Wilcox Company on Order NY-771802.

Miscellaneous control panels for operation of auxiliary equipment and indication of functions on piping systems include: Pulverizer Mill Panel, located on the mezzanine floor, Elevation 5138.5 near column "C13"; Boiler Feed Pump Auxiliary Panel, located at Elevation 5130 near column "B12"; Condensate Panel, located at Elevation 5130 near column "B11"; four (4) Ignition Panels, one (1) on each firing aisle located at Elevations 5155.0, 5163.0, 5171.0, 5178.0, and mounted on column "C13"; and a Turbine Gage Panel located on the mezzanine floor at Elevation 5138.5 near column "B11". All of these panels were furnished by Panellit, Incorporated on Order NY-771896.

Other panels include the Fuel Protection Panel purchased from Gustaveson, Incorporated on Order No. NY-771908 and located along the east wall of the cable vault room on the mezzanine floor, Elevation 5142.0 near column "Da15"; Soot Blower Contactor Panel furnished by Diamond Power Specialty Company for Babcock and Wilcox Company on Order NY-771802 and located near the compressors at column "Eall" on the ground floor, Elevation 5155.0; Steam Temperature Control Panel furnished by Babcock and Wilcox Company on Order NY-771802 and located adjacent to, in line with, and east of the Boiler Gage Panel at Elevation 5155.0; and an Auxiliary Boiler Gage Panel furnished by Panellit, Incorporated on Order NY-771896 and located at the operating floor, Elevation 5155.0, in line with, and west of the main boiler gage panel at column "C14".

Saturated steam is taken from the boiler at the superheater intermediate header and utilized for pegging steam on the deaerator, on auxiliary heat sources for the evaporator and for steam supply to the air heater coils during low load operation. The high pressure saturated steam is reduced from 1950 psig to 100 psig with a subsequent temperature drop from 635 degrees F to 340 degrees F by use of two (2) pressure reducing valves arranged parallel in a reducing station located at Elevation 5171 just west of column (Ea-11). Black, Sivalls and Bryson, Incorporated, furnished the reducing valves on Order NY-771903 and the B F Shaw Company installed them on their field contract, 3C-147.

The water softening facilities installed for Units 1 and 2 are also utilized for Unit 3. No additional water softening equipment was installed for Unit 3.

Boiler Plant Piping

In general, all boiler plant piping sized to two and one-half (2-1/2) inches in diameter and larger was furnished and fabricated by Midwest Piping and Supply Company on Order NY-771889 and installed by the B F Shaw Company on field contract Order 3C-147. All boiler plant piping sized two (2) inches in diameter and smaller, including all instrument and control tubing, was installed by our pipefitter forces. Valves and specialty items were furnished on the following orders: NY-771821, Atwood and Morrill Company; NY-771826, Schutter and Koerting Company; NY-771863, Yarnall-Waring Company; NY-771864, Manning, Maxwell and Moore Incorporated; NY-771870, Manning, Maxwell and Moore Incorporated; NY-771873, Industrial Materials Company; NY-771874, The Chapman Valve Company; NY-771875, The Franklin Supply Company; NY-771876, The Mine and Smelter Supply Company; NY-771877, Central Pipe and Supply Company; NY-771878, Grimes Pipe and Supply Company; NY-771879, American Pipe and Supply Company; NY-771903, Black, Sivalls and Bryson, Incorporated; NY-771909, The Mercoid Corporation; and NY-771911, Magnetrol Incorporated.

Pipe welders for the B F Shaw Company were qualified at the jobsite in accordance with B F Shaw Company qualifications. Pipe welders for Ebasco were qualified in accordance with Ebasco specification WQ-2 for carbon steel pipe and specification WQ-3 for alloy steel pipe. Test coupons of welds were examined radiographically and tested by U.S. Testing Company on local order 3C-411. Results and test coupons were then forwarded to Ebasco Metallurgical Department for final approval. Welds in the main steam, hot reheat, cold reheat, boiler feed discharge, 4th and 10th stage extraction, boiler steam drains, auxiliary steam and saturated steam from the boiler to the pressure reducing station were preheated and post heat treated to relieve stresses induced in the piping as a result of the welding operation. All piping systems were subjected to a hydrostatic test of 1-1/2 times design pressure before being placed in service.

Prefabricated pipe hangers and their supports were supplied by Bergen Pipe Support Corporation as a subcontract to the general piping contract.

Application of thermal insulation and lagging was accomplished by Insulation Services, Incorporated, on Order NY-771932. Specification PSCC-C3-125HI governed the type and thickness of materials used. The piping not lagged with sheet aluminum was painted by Schriber Decorating Company, the general painting contractor. All piping systems are marked with line identification and direction of flow in accordance with Public Service Company of Colorado standards.

Winterizing materials for outdoor equipment and piping were installed by Sturgeon Electric Company on their general electrical contract. Heating cable was furnished by Nelson

Electric Manufacturing Company on Order NY-771935 and General Cable Corporation on Order NY-771936.

Induced Draft Equipment

Flue gas is induced from the furnace section of the boiler downward through the convection section, containing the economizer, and into two (2) gas flues which connects to the dual air heaters. After passing through the air heaters and a dust collector, the gases are again split into two ducts and intake into the two (2) induced draft fans that exhaust thru the breeching, into the chimney and to atmosphere.

The dust collector is a multiclone mechanical separator manufactured by Western Precipitator Corporation, type 9YGR12-900-15, and furnished as part of the boiler contract by Babcock and Wilcox Company on Order NY-771802. The dust collector is capable of removing 5,850 pounds per hour of the dust and carbon particles from 1,540,000 pounds of flue gas per hour with inlet gas temperature 275 degrees F and a pressure drop of three (3.0) inches H_2O. Eight dust hoppers constructed of 3/16 inch steel plate and having a total storage capacity of 2570 cubic feet, equivalent to nine (9) hours of full load operation, are arranged below the separator to store the collected fly ash.

The dust collector shell and hoppers are insulated with one inch medium temperature block and lagged with 0.050 thick aluminum. The gas flue section from the air heaters to the dust collector, including its insulation and lagging, was also furnished as part of the boiler contract. Flue gas duct between the dust collector and the induced draft fans was furnished similarly. Foundations for the gas duct between the dust collector and the induced draft fans (17.2 cubic yards) were placed during July, August and September, 1960, and are recorded on field progress drawing 3C-P-3, "Substructure Foundations", included elsewhere in this report.

The induced draft fans are located east of the boiler, approximately 13.5 feet east of column line "M". Westinghouse Electric Corporation (Sturtevant Division) furnished the two (2) centrifugal, turbo-vane, double inlet, backwardly inclined vane, type 1011TVID induced draft fans for Babcock and Wilcox Company on Order NY-771802. Each fan is capable of handling 900,000 pounds per hour of flue gas at 272 degrees F, with an inlet pressure of minus 13.7 inches of water and an outlet pressure of zero inches of water. Westinghouse Electric Corporation furnished the 1000 hp outdoor, weather protected, direct connected motor drivers on Order NY-771813. The fans were tested the week of February 19, 1962, and turned over to the operating forces by Equipment Turnover Record, Sheet No. 12, dated March 12, 1962.

Each I. D. fan foundation is supported by two (2) eighteen inch and two (2) thirty inch diameter caissons. They were drilled and concreted (21 cubic yards) between July 11, and

July 18, 1960, as recorded on field progress drawing 3C-P-1, "Caisson Data - As Built", included elsewhere in this report. Machine excavation was accomplished on August 17, 1960, and consisted of 92 cubic yards. The foundations were concreted in two sections with the base mat section first and then the two piers, one for the fan outboard bearing and the other for both the fan inboard bearing and the motor base. Both base mat sections were placed January 3, 1961, and contained a total of 123.5 cubic yards. All piers were placed January 31, 1961, and contained 20.5 cubic yards. A record of the concrete placement is shown on field progress drawing 3C-P-7, "Equipment Foundations", included elsewhere in this report.

The breeching from the induced draft fans to the stack with its associated supports, ladders and walkways was furnished by Sterling Steel and Supply Company on Order NY-771907 and erected by our own forces. The ductwork is fabricated of one quarter inch thick copper bearing steel per ASTM specification A-283 grade "C" or "D" and painted inside and out with Cheeseman-Elliot heat resistive Primer No. 357. Wire mesh, 4" x 4", No. 8 gage, was spot welded to the breeching stiffeners; then, application of one and one-half (1-1/2) inch thick heat insulation was applied and lagged with .020 inch thick aluminum lagging. Insulation Services, Incorporated, furnished and applied the insulation and lagging on Order NY-771932.

The main breeching is supported on the I.D. fan foundations mentioned just previous in this section.

Gas recirculation is the primary attemporation feature for steam temperature control. The gas recirculating fans are located six feet, six inches, (6'-6") west of column line "Ja with the north fan three (3) feet south of column line 14 and the south fan three (3) feet north of column line 12. The fans were furnished by the Babcock and Wilcox Company on Order NY-771802, and are Westinghouse Sturtevant, Type 1008 TVID, centrifugal, double-width, double-inlet, with water cooled sleeve bearings capable of recirculating 69,400 cfm gas at 687 degrees F with a static inlet pressure of minus 2.5 inches H_2O and a static outlet pressure of 2.0 inches H_2O. Westinghouse furnished the two (2) 150 hp motor drivers on Order NY-771813.

Each of the two (2) gas recirculating fans are supported by three (3) eighteen (18) inch and one (1) thirty-six (36) inch caissons drilled into the Denver shale formation. They were drilled and concreted, (17.5 cubic yards), between July 7, and July 14, 1960, as recorded on field progress drawing 3C-P-1, "Caisson Data - As Built", included in the drawing section of this report.

Excavation was performed August 11, 1960, and contained 45 cubic yards of machine excavation and 11 cubic yards of hand excavation for a total quantity of 56 cubic yards. Concrete for fan 3B foundation base, (30 cubic yards), was placed August 27, 1960, and the 3A fan foundation base, (30 cubic yards),

was placed August 30, 1960. Motor and fan bearing piers for fan 3A were concreted March 10, 1961, containing 9.5 cubic yards and concrete for 3B fan was placed March 14, 1961, also containing 9.5 cubic yards. The foundations are shown on Drawing G-159765 and concrete placement is recorded on field progress drawing 3C-P-7, "Equipment Foundations", included elsewhere in this report.

The inlet ducts from the flue gas duct to the fan intakes and the discharge ducts from the fans to the lower east side of the furnace wall, including insulation and lagging, were furnished by the Babcock and Wilcox Company on Order NY-771802.

A stack was designed to serve Unit No. 3 and future Unit No. 4 based on an exit velocity for two (2) units. An orifice at the cap will not be provided for Unit No. 3 operation. Two (2) breeching openings are provided with the future Unit No. 4 blanked off. A baffle wall will extend from two (2) feet below to two (2) feet above the flue openings and placed at an angle of forty-five (45) degrees to the horizontal axis of the openings. The stack height to be the same as the one common to Units No. 1 and No. 2.

A ladder is furnished for the full height and inserts are provided for future balconies at the top and mid height. Aircraft warning lights are not provided but conduit is included as well as inserts for mounting future lights.

A 300 foot high reinforced concrete stack with a separately free standing brick lining complete with all accessories and appurtenances in accordance with Ebasco Specification No. PSCC-CH3-160 was purchased completely erected from Rust Engineering Company on Order No. NY-771845. The steel blank to cover the future Unit No. 4 opening was purchased from Sterling Steel and Supply Company on Order NY-771907. The unlined steel hopper for ashes in the bottom of stack was furnished by Denver Steel and Iron Works on local order No. 3C-422.

The stack foundation was started in the early stages of construction as the circulating water system was over part of the mat. Machine excavation started August 2, 1960, and by August 8, 1960, 901 cubic yards of dirt were removed. The upper sections of decomposed and soft shales were excavated by backhoe and the hard shale and trimming to neat lines was accomplished by manually operated air tools. 113 cubic yards of shale were removed by machine and 28 cubic yards by hand. Backfill was by machine except for that under and adjacent to the circulating water pipes where manually operated machine tampers were used. Excess dirt and shale excavation were hauled to and utilized in the railroad fill. The class D concrete seal, (20 cubic yards), was placed August 10 and 11.

On August 24, 342.5 cubic yards of concrete were placed for the circular foundation mat. The plinth was concreted September 20, and contained 233 cubic yards. The open interior

section of the plinth was backfilled with sand excavated from the jobsite. The concrete slab in the top of the plinth was not placed until after completion of the stack. The slab was concreted on December 19, 1961, and contained 8 cubic yards of concrete.

The reinforced concrete shell is 29 feet, 3/4 inches outside diameter and 13-1/4 inches thick at the base and tapers both faces to 23 feet, 4 inches outside diameter and 7 inches thick at the top. Rust Engineering Company used a timber derrick, steel slip forms and transit mixed concrete furnished by Western Concrete, Incorporated. The concrete was placed in seven and a half (7.5) feet lifts with the first lift placed April 11, 1961, and the final (40th) lift placed July 7, 1961, using a total of 605.5 cubic yards of 3500 psi concrete with "Protex" air entrainment.

The brick lining is 19 feet, 6 inches inside diameter, sixteen (16) inches thick for the lower one hundred (100) feet, twelve (12) inches thick for the next one hundred twenty (120) feet and eight (8) inches thick for the upper eighty (80) feet. The lining is reinforced on the outside by circumferential steel bands of three (3) inches by one quarter (1/4) inch spaced every four (4) feet. Bricklaying started July 18, 1961, and was completed September 18, and the baffle wall was completed between September 26, and October 2.

Erection of the cast iron cap was completed September 20, 1961. Erection of the ash hopper in the base of the stack started November 29, 1961, and welding was completed December 15, 1961, with the work performed by our ironworker forces. The blank over future No. 4 opening was erected between December 18, and December 26 by our boilermaker forces. The blank was insulated and lagged by Insulation Services under the Order No. NY-771932.

TURBO-GENERATOR UNIT

Pedestal

The turbine generator pedestal is located in the turbine room from Elevation 5120 to operating floor level at 5155, bounded by column lines "A", "B", "11-1/2", and "15", as shown on Drawing G-159739. It is approximately 87 feet long by 31 feet wide. The pedestal and its foundation are entirely separated from adjacent building structure. The foundation mat is separated from building column caisson caps and circulating water tunnels by 1/2 inch premoulded joint filler. The ground floor slab is isolated from the pedestal legs by the same material. At the mezzanine floor, the grating is supported by the building frame and clears the pedestal. At the turbine room operating floor, a one (1) inch opening between the pedestal and adjacent floor slabs was filled with sponge rubber two inches deep and sealed with a thiocol rubber compound.

The foundation was excavated in sound shale with all questionable material below grade removed and replaced with 4 sack class "D" concrete (36 cubic yards). Excavation was performed by bulldozer for the top 3 feet of weathered shale and by a one (1) cubic yard backhoe for the next six (6) feet of Denver formation shale and sandstone, with hand dressing as the subgrade required.

A reinforced concrete mat, 31 feet wide by 84 feet, 6-1/2 inches long and 6 feet thick was concreted, (574-1/2 cubic yards), on October 14, 1960. Concrete was supplied by Ready-Mixed Concrete Company on Order 3C-17. Utilizing the full output of the supplier's closest batch plant plus occasional trucks from another plant, the concrete was placed at an average rate of 70 cubic yards an hour.

The pedestal was concreted, (947 cubic yards), in three sections, November 10, 1960, and November 16, 1960, for the south and north lower sections respectively and January 18, 1961, for the upper portion. Structural timbers, wide flanged beams, and prefabricated panels were utilized in a field office design for the forming. A jurisdictional labor dispute between the carpenters and ironworkers over setting of structural steel shoring delayed the forming period for the upper portion. A field designed steel frame anchor bolt template was fabricated by August Frederichs Company on Order 3C-155 from material furnished by us. The upper lift was placed with the use of three (3) cranes in an eight-hour period. Auxiliary steam from the operating plant was used for curing. The embedded miscellaneous steel was furnished by Metalcraft on Orders 3C-41 and 3C-137.

Turbine Generator

The turbine generator unit is a General Electric handbook, indoor type with gear driven exciter to develope 150

megawatts at normal throttle conditions of 1800 psig, 1000 degrees F/1000 degrees F reheat, 3600 rpm, tandem compound double flow, bottom exhaust, when operating at 3.5 inches of mercury absolute back pressure. Guaranteed turbine generator gross heat rates and steam rates with throttle steam pressure of 1800 psig and turbine exhausting at 1.5 inches mercury absolute back pressure are as follows:

Percentage of turbine rating	31.4	53.3	76.6	100.6	104.0
Steam temperature F-throttle	988	1000	1000	1000	1000
Steam temperature F-reheater	960	997	1000	1000	1000
Final feedwater temp F	387.1	432.2	470.3	505.2	510.1
Gross heat rate,Btu/kwh	8703	8121	7912	7872	7878
Steam rate-throttle,lb/kwh	6.70	6.46	6.59	6.89	6.95
Steam rate-reheater,lb/kwh	5.85	5.54	5.54	5.67	5.70
Steam rate-condenser,lb/kwh	5.08	4.65	5.53	4.53	4.54
Reheater inlet pressure,psig	126	215	315	428	445
Heat added in reheater,Btu/lb	212.1	218.1	207.0	188.5	185.1
Load on Unit, MW	47.1	80.0	114.8	150.9	156.0
Throttle flow, M lb/hr	315	517	757	1040	1085

The turbine is a condensing, tandem compound double-flow, horizontal shaft, multi-stage, reheat, two cylinder, 3600 rpm unit. The unit has a nameplate rating of 150,000 kw; however, during initial trials, the unit has produced power at a rate of 170,000 kw with normal condenser vacuum, rated steam conditions and the full complement of regenerative heaters in service. There are twenty impulse stages, seven single high pressure stages, seven single intermediate pressure stages and six double-flow pressure stages. The exhaust is bottom, downward into the condenser.

Under conditions of maximum continuous boiler operation, 1,140,000 pounds of 1800 psig, 1000 degrees F steam enters the turbine from the superheater; 900 pounds are bled to the control valve seals; 9,700 pounds to the shaft seals; 78,600 pounds to the 4th stage heater; 20,500 pounds direct to the intermediate pressure section of the turbine; 97,300 pounds to the 7th stage heater and 933,000 pounds of 462.2 psig, 669 degrees F steam to the reheater in the boiler. Reheat steam in the amount of 933,000 pounds of 434 psig, 1000 degrees F steam is returned to the intermediate turbine section. 202,100 pounds are bled to the other six extraction feedwater heaters and evaporator, and the remaining 751,400 pounds are exhausted from the low pressure turbine into the condenser at 2.5 inches of mercury.

The 4th, 7th, 10th, and 12th stage bleeds go to the respective high pressure heaters; the 14th stage bleed goes to the deaerator; and the 16th, 17th, and 18th stage bleeds go to the respective low pressure heaters.

Turbine speed is controlled by a rotating pilot valve governor, which maintains required speed within approximately five (5) percent, and with an adjustment to values between two (2) and seven (7) percent of rated speed. There is also

an emergency overspeed governor, an automatically tripped eccentric spring loaded ring, which operates at 112 percent of rated speed.

Excessive exhaust temperature in starting or at low load is prevented by automatically operated water sprays with a manual bypass. All of the shaft seals are of the labyrinth type. There is also an initial pressure regulator which closes the turbine control valves when pressure in the boiler drops below a predetermined level.

The turbine is insulated with plastic heat retention material and with metal lagging over the high temperature parts. The insulation for the lower half of the high pressure shell was applied by Construction Specialties, Incorporated on Order 3C-399 before placing this piece into position while there was good accessibility. The remaining insulation was applied by Insulation Services, Incorporated on Order NY-771932.

The generator is a direct connected, horizontal revolving field, liquid cooled stator, gas cooled rotor and is rated at 154,959 kw, 182,305 kva at 0.85 power factor, 5,263 amperes, 20,000 volts, 3 phase, 60 cycles, 3600 rpm, with a short circuit ratio of 0.64. At full load and 0.85 power factor, the efficiency is 98.6 percent with 30 psig hydrogen.

The generator capabilities at various hydrogen pressures are as follows:

kva	Short Circuit Ratio	Power Factor	psig Hydrogen
109,383	1.065	0.85	15
182,305 (rated)	0.64	0.85	30
200,535	0.582	0.85	45

The generator will operate satisfactorily but not necessarily within temperature limits with a capability of 145,845 kva at 0.85 power factor, 30 psig hydrogen with one (1) section of the hydrogen coolers out of service when stator cooling system is operating at rated level. The capacity of the generator is 73,059 kva with all hydrogen coolers in service and the stator liquid cooling system not in service at either 30 psig or 45 psig hydrogen.

The generator will operate satisfactorily but not necessarily within temperature limits with a capability of 145,845 kva at 0.85 power factor, 30 psig hydrogen with one (1) section of stator liquid coolers out of service.

The generator windings are arranged for wye connections and are suitable for operation with the neutral grounded through a transformer. All six (6) terminals are brought out for phase terminating. Each bushing accomodates three bushing current transformers (nine in all - two on each neutral terminal and one on each line terminal). rated at 7000/5 amperes. Flexible

connectors connect the terminals to the metal clad isolated phase bus. The current transformers and connectors furnished as part of the turbine-generator Order, (NY-771801). The main exciter is rated at 740 kilowatts and is geared to the main shaft at 890 rpm. The main exciter current and voltage at rated load is 15.4 amperes and 96.3 volts on the field winding. The voltage regulator is an amplidyne regulator with line-drop compensation. The main exciter rheostat is motor operated, 125 volt d-c. The exciter is ventilated thru a duct system with its intake located on the pedestal mezzanine level between columns "14" and "14-1/2" at the east side, with American recleanable filters and furnished with the turbine generator order.

General Electric also furnished the three cubicle compartment on the mezzanine platform of the pedestal, which contains the voltage regulator, the generator field air circuit breaker and the motor operated field rheostat.

The turning gear, also supplied by General Electric as part of the turbine generator order, is motor operated, electrically interlocked with a motor-driven turning gear oil pump.

The turbine generator was originally scheduled to ship in June, 1960, but was completed earlier than scheduled, so permission was granted to ship on completion with payment terms based on original shipping dates. Work commenced for setting base plates on February 20 with the arrival of the erector. Sub-sole plates were not used and the base plates were dry packed with grout on March 9, 1961, after final positioning. The turbine low pressure exhaust section was set in position April 18, 1961.

The generator stator is the heaviest piece of the turbine generator assembly and weighs 335,400 pounds. It was shipped on a special flatcar, with restricted handling and routing. The station gantry crane installed for Unit No. 1 has a rated capacity of 175 tons with an allowable overload of thirty (30) percent. A manufacturer's service engineer was retained to make a thorough structural, mechanical and electrical check before handling the stator. On April 20, 1961, the stator was unloaded from the flatcar and carried the length of the turbine room and set over its anchor bolts.

With the early start, the erection proceeded with a limited crew and was ready for oil flush the first of December, 1961. Oil was flushed on an eight hour day basis until February 26. The extended oil flush period was due to the cooling of the oil overnight and to a lint like material which was troublesome in clearing up. Oil was refiltered and the tank again cleaned immediately before the stretch-out.

The turbine was first rolled with steam April 27, 1962, brought up to speed on April 28 and trial operation was

realized that date at 5:31 p.m. The turbine generator was turned over to the operating department on Equipment Turnover Record, Sheet No. 50, dated June 22, 1962.

The hydrogen cooling system is used for rotor cooling only as the stator is oil cooled. The hydrogen system, a part of the turbine generator order, is designed so that the temperature of the hydrogen leaving the coolers shall not exceed 114.5 degrees F, under the following conditions of load:

kva	Power Factor	Hydrogen psig	Heat absorbed Million Btu per Hour
200.535	0.85	45	5.72
182,305	0.85	30	4.95
136,728	0.85	30	3.73
45,576	0.85	30	2.07

Loss of hydrogen is guaranteed not to exceed amounts indicated in the following data at the operating pressures shown:

Hydrogen Pressure	Guarantee	Expected
0.5 psig	100 cuft/day	50 cuft/day
15.0 psig	250 cuft/day	150 cuft/day
30.0 psig	400 cuft/day	250 cuft/day
45.0 psig	500 cuft/day	350 cuft/day

The hydrogen supply comes from an extension to the existing system installed for Unit No. 1. The header extension is located outside along the west wall at Elevation 5151.17 with a protective shield.

There are four hydrogen coolers which require a total of 750 gpm of cooling water entering at 90 degrees F and leaving at 103.6 degrees F. At rated conditions, hydrogen enters the coolers at 137 degrees F and leaves at 114.5 degrees F. The hydrogen control panel is located along with the stator oil cooler panel on the ground floor level northwest of the pedestal. The hydrogen seal oil unit is immediately south of the control panel and both were furnished with the turbine generator unit. The seal oil unit and its associated hydrogen piping were turned over to the operating department on Equipment Turnover Record, Sheet No. 39, dated May 7, 1962.

The CO2 control manifold is located at ground level under the west side of the pedestal between columns "13" and "14". To purge the cooling system of hydrogen, 3600 cubic feet of CO2 are required and for purging of air, 1800 cubic feet are required.

The turbine piping consists of that piping furnished with the turbine-generator unit by General Electric Company on Order NY-771801, and consists of steam leads and lubricating

oil piping. The steam piping was installed by B. F. Shaw Company on a field erection contract, Order 3C-147. When blowing out the hot reheat piping, a 16" outlet pipe was used to replace the 8" shown on the drawings on the west intercept valve in order to get a more effective cleaning velocity through the lines. This enabled a steam flow such that four cones could be seen at the outlet. The remaining oil, gas, and control piping were installed by our pipefitter forces. Insulation was applied by Insulation Services, Incorporated on Order NY-771932. Accessories furnished for these piping systems include: Main throttle stop valves with solenoid trip, intercept and reheat stop valves, steam strainer with removable element and temporary startup fine mesh strainers, low vacuum tripping device and an oil operated overspeed trip.

The turbine lubricating oil system consists of one (1) main oil pump, one (1) auxiliary oil pump, two (2) turning gear oil pumps, two (2) oil coolers, and the requisite regulators, storage tank, piping, instruments and accessories. The main oil pump is driven by the turbine shaft and has a capacity of 685 gpm. The auxiliary oil pump is driven by a 440 volt a-c motor and has a capacity of 1030 gpm. The turning gear oil pumps each have a capacity of 388 gpm and are motor driven, one by 440 volts a-c and the other by 125 volts d-c. The total quantity of oil required to fill the system is 4,150 gallons and 4,482 gallons of oil was purchased from Mobil Oil Company on Order 3C-744.

The main reservoir with a 3350 gallon capacity is equipped with high and low level float operated switches and a low oil level alarm. It is located at Elevation 5130 southwest of the turbine pedestal along the west wall between columns "10" and "12" on a reinforced concrete foundation (21-1/2 cubic yards) placed on March 13, 1961. The tank was set on its supporting steel frame thru a temporary opening left in the operating floor on April 13, 1962.

The two (2) lubricating oil coolers located on the turbine oil tank handle 187,000 pounds per hour or 427 gpm of oil. 450,000 pounds per hour or 902 gpm of cooling water enters the coolers at 90 degrees F and leaves at 96 degrees F to cool the oil from 139.2 degrees F to 115 degrees F. The heat exchange is 2.112 million Btu per hour. The coolers are of General Electric manufacture. There is a single oil pass and two water passes. The cooling surface is 822 square feet.

The complete lubricating oil system including all piping was turned over to the operating department by Equipment Turnover Record, Sheet No. 35, dated May 7, 1962.

The stator liquid cooling system utilizes Transil oil, Type 10CA with a density of .85 and a rate of circulation of 171 gallons per minute (maximum). It consists of two (2) coolant pumps, two (2) vacuum pumps, two (2) coolers, two (2) filters, an oil reservoir, a temperature control system, control

panel and necessary piping.

The two (2) coolant pumps, each with 225 gpm capacity and driven by a 440 volt a-c motor and the two (2) vacuum pumps, each driven by a 3/4 hp, 440 volt a-c motor, are all mounted on a common base. The reinforced concrete foundation is located between the northwest turbine pedestal leg and the north end of the building (column line "15"). The concrete (5 cubic yards) was placed on April 4, 1961, as recorded on progress drawing 3C-P-7, "Equipment Foundations", included elsewhere in this report. The No. 3A and No. 3B pumps and the No. 3A and No. 3B vacuum pumps were turned over to the operating department on May 7, 1962, by Equipment Turnover Record, Sheet Nos. 45, 46, 47 and 48, respectively.

The horizontal oil reservoir with a storage capacity of 400 gallons is hung from the operating floor steel framing above and to the east of the pumps with a centerline Elevation of 5147.12.

The horizontal coolers are mounted on separate reinforced concrete foundations located on the ground floor level under the north end of the turbine pedestal mezzanine floor. The foundations are each approximately eight (8) feet long, two (2) feet wide, with an eighteen (18) inch mat and piers at either end. They contain two (2) cubic yards of concrete placed March 27, 1961. The stator oil coolers were turned over to the operating department on May 7, 1962, by Equipment Turnover Record, Sheet No. 41, for No. 3A and 42 for No. 3B.

The vertical oil filters are floor mounted (Elevation 5130) adjacent to the north side of the east center leg of the turbine generator pedestal. They were turned over to the operating department on May 7, 1962, by Equipment Operating Record, Sheet No. 43, for No. 3A and Sheet No. 44 for No. 3B.

The control panel is the north cubicle of a two cubicle panel that also includes the hydrogen control. It is floor mounted on the ground floor, (Elevation 5130) northwest of the northwest leg of the turbine pedestal.

Rated conditions provides for a 72 degree F temperature drop in the oil when entering the coolers at 185 degrees F. Water enters the coolers at 90 degrees F and leaves at 107 degrees F. Cooling duty is as follows:

% of Rating	Load kva	Power Factor	Heat Absorbed Million/ Btu per Hour
110	200,535	0.85	2.45
100	182,305	0.85	2.05
75	136,728	0.85	1.14
50	91,152	0.85	.51
25	46,576	0.85	.14

Minor accessories supplied as part of the turbine generator order include: 62 resistance type temperature detectors located in the generator armature slots, generator cooling gas chamber, exciter air ducts and generator stator liquid coolant. Surge protection consists of three outdoor type 0.125 mfd 23 kv capacitors and three 19.5 kv lightning arrestors.

Condenser and Auxiliaries

The horizontal condenser with integral hotwell is located directly under the turbine exhaust and was furnished, together with erection superintendence, by Yuba Heat Transfer Division on Order NY-771803. Specifically, it is a 55,000 square foot surface, divided water box, single pass condenser with fabricated steel shell. The hotwell has a storage capacity of 1130 cubic feet. Also provided was an opening and bracing in the condenser neck for installation of a low pressure feedwater heater. The 8,050 inhibited admiralty metal tubes 7/8 inch OD, 18 BWG, 30 long, (effective length of 29'-9'-4") were supplied independently by Chase Brass and Copper Company on Order NY-771906.

The condenser is rated as having a duty equal to 720 million Btu per hour. During full load, 751,400 pounds per hour of steam enter from the turbine at 2.5 inches of mercury which discharge as condensate to the condensate pumps. 95,000 gpm of circulating water enter the condenser at 80 degrees F and leave at 95.1 degrees F. The condenser was originally scheduled for April, 1960, shipment but was shipped in February, two month early.

Shell assembly started on March 6, 1961, outside the west wall on timber cribbing and railroad rails. It was skidded on greased railroad rails into position on March 29, 1961. Half of the tubes arrived on April 21, and stabbing into the tube sheets started April 24. The balance were received May 9, and tubing was completed May 31, 1961. The hydrostatic test on the steam side was completed June 5, 1961, with one tube leak. The tube was plugged as no spares were purchased. The condenser is supported on four reinforced concrete piers which were concreted (13-1/2 cubic yards) on April 11, 1961. The condenser was in service April 19, when the circulating water system was tested and was turned over to the operating department on May 7, 1962, by Equipment Turnover Record, Sheet No. 40.

The vacuum in the condenser is established by the steam jet air ejector, which was also furnished by Yuba Heat Transfer Division on Order NY-771803. This ejector is a twin-element two stage ejector, mounted on a combined shell inter-and-after condenser. Equipment furnished with this ejector includes cast iron bodies of the primary and secondary jets; chrome moly steam chest; stainless steel nozzles and cast iron diffusers; a set of reducing orifices to reduce the initial steam from 1925 psig and 1015 degrees F to operating pressure of 325 psig and 938 degrees F; all manifolds, interconnecting steam piping, valves, strainers and controlling devices. The steam jet air

ejector is set on supports supplied along with the main building steel located on Elevation 5138 between columns "A", "Aa" and "13-1/2", "14". With both elements in operation, 262.5 pounds per hour of dry air and water vapor are evacuated with a back pressure of 1.0 inch of mercury requiring 1030 pounds per hour of steam and 62,500 pounds per hour of cooling water. Condensed steam is returned to the condenser hotwell. It was turned over to the operating department on May 7, 1962, by Equipment Turnover Record, Sheet No. 37.

The priming ejector, which evacuates the steam passages in the condenser at startup, was also furnished by the Yuba Heat Transfer Division, NY-771803. It consists of a single stage non-condensing ejector capable of exhausting 600 cubic feet of dry air at 15 inches of mercury absolute. With this equipment is a reducing valve for reducing 1925 psig steam to operating pressure of 325 psig, and a pressure gage. This equipment is located beside the steam jet air ejector. It was turned over to the operating department May 7, 1962, by Equipment Turnover Record, Sheet No. 38.

The three condensate pumps (two operating) are part of the feedwater system removing 415,000 pounds per hour each of condensate from the condenser hotwell, and forcing it through the low pressure heaters to the deaerator. They are located between columns "A", "Aa" and "10-1/2", "11-1/2" on the ground floor Elevation 5150. The pumps were furnished by Yuba Heat Transfer Division on Order NY-771803 and are Ingersoll-Rand vertical turbine type, in can, four stage, each handling 832 gpm against a total dynamic head of 400 feet. The 125 hp motors were furnished by Westinghouse Electric Corporation on Order NY-771813. Condensate pump motor No. 3B top bearing failed during startup and was replaced by Westinghouse. The pumps were tested during the week of February 26, 1962, and turned over to the operating department March 12, 1962, by Equipment Turnover Record, Sheets Nos. 14, 15 and 16.

The reinforced concrete foundations were concreted (26-1/2 cubic yards) on January 23, 1961, as recorded on construction progress drawing 30-P-7, "Equipment Foundations", included elsewhere in this report.

Circulating Water System

The circulating water system is a closed circuit and consists of a main cooling tower with the circulating pump intake chamber at the tower end; a combination angle and terminal tunnel section adjacent to the intake chamber; interconnecting seventy two (72) inch diameter lock joint reinforced concrete pipe thru the yard areas including an angle tunnel block for directional change; tunnel sections under the boiler and station building; and steel piping from the tunnels to the cooling tower on one end and to the condenser on the other end; as shown on Drawing G-159711 "Circulating Water System - General Plan and Profile."

The cooling tower is adjacent to coal storage yard track No. 1 oriented north northwest and south southeast with the center of the south wall 520 feet east of column "A" and 202.17 feet north of column "15".

The reinforced concrete basin is 251'-4" long by 49'-5-1/2" wide (inside measurements) and the elevation of the 12 inch thick base slab varies from Elevation 5125.83 to 5124.50 with the operating water level at Elevation 5129.0 and the top of the 20 inch thick reinforced concrete walls at Elevation 5130.

Excavation for the basin was included in field contract, Order 3C-145, with Winslow Construction Company at the time of the ash basin installation in June, 1961, with the excavated material used in the ash pond embankments.

The reinforced concrete slab and walls were placed between June 6, and August 15, 1961, (691 cubic yards). Pozzolith concrete additive was used for the bottom slab and for wall sections No. 3 east, No. 3 west, No. 4 east, No. 4 west, and No. 6 east as per Public Service Company of Colorado engineering department requirements. After stripping forms from these wall sections, the surface porosity seemed excessive and air entrainment was used on the remaining 10 wall sections and all interior piers. The surface texture was improved a great deal on the later placements. The record of concrete placement is shown on field progress drawing 3C-P-5, "C.W. Cooling Tower Basin and Intake", included elsewhere in this report.

The cooling tower superstructure was supplied and erected by the Marley Company on Orders NY-771828 and NY-771829 respectively. Erection was started on August 28, and completed on November 9, 1961. All timber in the cooling tower is Marlith treated fir except the distribution headers and fan stacks which are redwood. Interior fill hangers are of fiber-glass material, end walls and side louvers are of corrugated asbestos siding material. This 9 cell in line, Marley model 653-3-09, induced draft, double flow tower will cool 95,000 gpm of water entering the tower at 95.1 degrees F to 80 degrees F. Height of the tower is 35'-4" from the top of the basin wall to the fan deck. The cooling tower was turned over to the operating department on June 22, 1962, by Equipment Turnover Record, Sheet No. 68.

After erection, a sprinkling system was installed with connections to the yard fire protection system for keeping the tower damp until it would be placed in operation. This system was left in place for future use in case tower is idle for an extended period.

The nine Marley type H-3-P fans are 22 feet diameter, each with 12 cast aluminum blades, 157 rpm, 10,870 fpm tip speed, and each fan moves 862,000 cfm. Speed reducers were also furnished by Marley. Motors are one speed 125 hp, 1800 rpm and were purchased from Westinghouse Electric Corporation on Order NY-771813. Fan stacks are venturi type approximately twenty two (22) feet diameter by 14'-4" high. Fan direction

can be reversed for de-icing during winter operation. Each fan was checked for rotation, tested and run-in for two hours on April 19 and 20, 1962, under the direction of manufacturer's service engineer. The nine fans numbered No. 3A through No. 3I were turned over to the operating department on May 7, 1962, by Equipment Turnover Record, Sheets No. 26 through No. 34.

Circulating water leaves the south end of the cooling tower basin through a reinforced concrete intake structure where the two circulating water pumps are located. The reinforced concrete intake structure shown on Drawing G-159731, "Circulating Water System Intake - Masonry". It contained 312 cubic yards of class B concrete which were placed between November 2, 1960, and May 19, 1961, as recorded on construction progress drawing 3C-P-5 "C.W. Cooling Tower Basin and Intake", included elsewhere in this report.

Steel plates one and one-half inches thick were anchored and grouted in the intake structure bottom slab directly under the pump suctions to prevent cavitation of the concrete and were purchased from Metalcraft Welding and Fabricating Company on Order 3C-137.

Other imbedded parts in the intake structure include anchor bolts furnished by Sterling Steel and Supply Company on Order 3C-77; ladder rungs, screen and stop log guides and pipe sleeves were furnished by Metalcraft Welding and Fabricating Company on Orders 3C-61, 3C-96 and 3C-126, respectively. The galvanized screens were furnished by Sterling Steel Company as part of Order 3C-77.

The structural steel framing for the hoist handling stop logs, screens, circulating water pumps and motors was also furnished as part of Order 3C-77 from Sterling Steel and Supply Company. The walkway from the cooling tower to the existing walkway connecting cooling towers No. 1 and No. 2 was furnished by Metalcraft Welding and Fabricating Company on Order 3C-725.

The fourteen (14) ton Robbins and Meyers bridge crane with hand chain, propelled geared trolley was supplied by Materials Handling Equipment Company on Order 3C-828.

The circulators are set on the intake basin at the south end of the cooling tower from where the water is discharged to the conduits which run thru the plant area south of Unit 3 chimney, along the north side of the boiler and into the building along the south side of column line "15"; then turns south to either side of the condenser.

The two (2) circulating water pumps are Ingersoll Rand vertical non-removable element, type 36APM-2, two (2) stage with a capacity of 47,500 gpm against a total dynamic head of 63 feet with 7 foot submerged section. They were furnished by Yuba Heat Transfer Division on Order NY-771803 and the 950 hp motors were furnished by Westinghouse Electric Corporation, Order NY-771813. The pumps were test operated April 19, and

were turned over to the operating department on May 7, 1962, by Equipment Turnover Record, Sheet No. 24, for No. 3A and Sheet No. 25 for No. 3B.

The circulating water conduits thru the station building and boiler areas to a directional transition near the chimney are reinforced concrete tunnels. Blocks are numbered as shown on Drawing G-159711, "Circulating Water System - General Plan and Profile", with Blocks Nos. 1, 2, 3, 4, 5 and 6 single conduit around the turbine generator foundation and the balance twin conduit. Block No. 7 is a transposition from the two single conduits into one twin conduit. Block No. 13 is a transposition to concrete pipe. Block No. 14 is a directional transition piece between sections of the seventy two (72) inch reinforced concrete piping. Block No. 15 is a transposition from concrete pipe to twin conduit tunnel near the intake structure and Blocks Nos. 16 and 17 are the terminal sections.

Blocks 1, 6, 16 and 17 have reinforced concrete collars around the 48 inch steel pipe imbedded sections for inlets and outlets at the condenser and cooling tower. Block No. 17 has manhole accesses and is the low point in the system. Valve operated drains begin at Block 17 and terminate in an existing storm sewer manhole east of the intake structure.

Between tunnel Blocks No. 13 and 15, two 72 inch diameter reinforced concrete pipe are laid nine (9) feet on center containing a total of 577.08 linear feet. The intake line is designed for total dynamic operating head of 65 feet of water and maximum 110 feet. The discharge line is designed for a total dynamic pump shut-off head of 50 feet of water and water hammer head of 60 feet. The pipe and fittings were purchased from Lock Joint Pipe Company on Order NY-771844. Installation was performed between September 26, and November 25, 1960. This installation was slowed somewhat because of underpinning and supporting the large amount of piping south and east of the water treatment building serving the existing units.

Steel pipe, 48 inches in diameter, connects the tunnels to the cooling tower at one end and to the condenser at the other end and was supplied on Order NY-771865 by Eaton Metal Products Company. Four butterfly valves, 48 inches diameter, were installed in the circulating water lines at the condenser and two (2) motor operated butterfly valves, 54 inches in diameter, were installed at the C.W. pump discharge, all supplied on Order NY-771822 with H. Pratt Company. Six (6) rubber expansion joints, 48 inches in diameter, were purchased from Moisson Packing and Rubber Company on Order NY-771832.

Excavation in shale for the tunnel sections around the turbine generator foundation was performed by a one cubic yard backhoe except fine grading beginning July 11, 1960, when excavating for the turbine generator mat. Lower material was shale and fine grading was by hand. Machine excavation continued for remaining tunnel and pipe sections and this installation was completed April 17, 1961. Total excavation quantities

were: Earth by machine, 3,016 cubic yards; earth by hand, 471 cubic yards; Shale by machine, 1,132 cubic yards; shale by hand, 100 cubic yards.

The concrete tunnel sections excavated in shale used 137 cubic yards of Class D concrete as a seal coat and Block No. 14 anchors. The tunnels contained 1,047 cubic yards of Class B concrete and the record of concrete placement is shown on field progress drawing 3C-P-4, "Circulating Water Conduits", included elsewhere in this report.

The concrete pipe was bedded in a course sand supplied from a pit source on the job site and a 17 foot wide by 40 foot long concrete cradle was used for pipe support under the road and railroad track serving the water treatment plant. Class B concrete was used and placed on October 7, and October 12, 1960, containing 60-1/2 cubic yards.

Circulating Water Treatment

Chlorine and polyphosphate treatment of the cooling water were provided for by connecting to the facilities in the water treatment building installed for Unit No. 1. Chlorine rubberlined piping, chlorine control valve, and polyphosphate plastic piping were purchased from Wallace and Tiernan, Inc. on Order NY-771937. Two polyphosphate pumps were installed and tied to existing piping for supply. These are 84 gph capacity and were furnished by Milton Roy Company on Order NY-771866.

Milton Roy, on Order NY-771866, also supplied three 15 gph acid pumps, an acid feed control panel, and accessories. Two acid pumps are for Unit No. 3 main cooling tower and the other for treating the increased load on the existing service water cooling tower. The panel provided space for future Unit No. 4 controls.

The second acid tank of 16,000 gallon capacity located directly north of existing tank, was added and supplied by American Steel and Iron Works, Incorporated on Order NY-771912. Cradle type foundation was concreted, (9-1/2 cubic yards), on October 11, and 16, 1961.

The acid feed piping to Unit No. 2 main cooling tower was relocated and included in the ash piping trench from south of the water treatment building to the point where the acid line goes under coal track No. 16 eastward toward the tower.

A lead lined trough and small water supply line for mixing the acid and water at cooling tower No. 3 were installed in lieu of the acid diffuser. The plant maintenance department had just installed this "homemade" diffuser as the previous diffusers had been a continuing source of trouble. New York engineering had the manufacturer revise the diffuser and Public Service Engineering advised New York at time order was placed to proceed with the new type of diffuser as this "homemade" arrangement was just being tried out. However, by the time

installation was to be made, it was decided that the year plus service and the simplicity of the lead lined trough not to install the manufactured diffuser. The manufacturer was contacted regarding a credit for returning the material, but due to the specific design for each job, they would not accept a return. This material is retained in the plant warehouse for possible future use.

Circulating Water Make-Up System

Three settling ponds fed from the South Platte River via the Farmers and Gardeners Ditch and four 600 gpm shallow wells were provided for Unit No. 1 and contain a sufficient make-up supply for Unit No. 3.

A new pump was added on the settling pond intake structure which had been provided with future cells during initial construction. The pump is a vertical two stage, turbine type, open suction with 3,000 gpm capacity at 120 foot head supplied by Worthington Corporation on Order NY-771838 driven by a 125 hp motor by Westinghouse Electric Corporation on Order NY-771813. The pump was tested on March 14, and turned over to the operating department by Equipment Turnover Record - Sheet No. 49, dated March 15, 1962.

The existing 12 inch make-up piping system installed for Unit No. 1, extended for Unit No. 2, does not have sufficient capacity for Unit No. 3. A new 18 inch pipe was installed from the pump discharge header and parallels the existing system through the metering pit along the east side of C. W. cooling tower No. 1 to cooling tower No. 3. This pipe has excess capacity and can be extended for future units. A 6 inch tap from this line serves as an emergency make up for the ash water requirements. A flow meter with connections installed in the existing pit and mounted alongside the present meter on top of the pit was furnished by Bailey Meter Company on Order NY-771854. The diaphragm control valve was furnished by Black, Sivalls and Bryson on Order NY-771903 and was installed on the west side of C. W. cooling tower No. 3 near the point of entry to the basin.

Turbine Room Auxiliaries

The batch oil reservoir and transfer pump installed for Unit No. 1 were designed for full plant operation and serve this unit with only a pump, filter and piping connections required.

The turbine lubricating oil filter pump, with a capacity of eight gpm, is located on Elevation 5130 in the turbine oil room and was purchased on Order NY-771861 with Worthington Corporation. The lube oil filter is located on the mezzanine floor level above the filter pump with a capacity of eight gpm and was furnished by Alsop Engineering Corporation on Order NY-771857.

Fire protection for the turbine lubricating oil tank is part of a system that also protects the main and unit auxiliary transformers. The description is detailed under the transformer writeup in the Accessory Electrical Equipment section of this report.

The turbine supervisory and startup panel is located directly south of the turbine on the operating floor. This equipment was supplied by General Electric Corporation and included with the turbine generator Order NY-771801. Instruments on the panel include speed recorder, eccentricity recorder, shell and differential expansion recorder and vibration recorder. General Electric also furnished the following instruments for mounting on the Boiler-Turbine-Generator control board: Eccentricity indicator, shell expansion indicator and differential expansion indicator.

The turbine gage panel located adjacent to the south side of column "B11" on mezzanine floor (Elevation 5138.50) was also fabricated by Panellit, Incorporated on Order NY-771896 and furnished with the following instruments: Steam to SJAE pressure transmitter, throttle pressure transmitter, main steam master transmitter, turbine 1st stage pressure transmitter, high pressure turbine exhaust transmitter, hot reheat steam at turbine pressure transmitter, turbine reheat bowl pressure transmitter, 4th, 10th, 12th, 14th, 16th, 17th and 18th stage pressure indicators and cold reheat steam temperature transmitter, main steam master high pressure alarm switch and main steam master low pressure alarm switch, both connected to annunciator.

A control cabinet of two panels for the generator hydrogen cooling and stator cooling oil systems was furnished by General Electric Company under their turbo-generator order, NY-771801. The left hand panel for the hydrogen system has the following instruments: Differential fan pressure gauge, machine gas pressure gauge indicating and transmitting, flow meter, annunciator, milliammeter, remote alarm hydrogen cutout switch, rheostat, vacuum pump selector switch with indicating lights, emergency seal oil pump selector switch with indicating lights, temperature meter and purity indicator. The right hand panel for cooling oil system contains the following instruments: Armature cooling oil inlet pressure gauge, main pump discharge pressure gauge, vacuum gauge, annunciator "A" vacuum pump pushbutton with indicating lights, "B" vacuum pump pushbutton with indicating lights, "A" main oil pump selector switch with indicating lights, "B" main oil pump selector switch, oil remote alarm cutout switch, throttling valve Bailey selector station, three-way valve Bailey selector station and Foxboro temperature recorder.

The condenser auxiliary panel is located southwest of column "B11" on the ground floor (Elevation 5130) and was fabricated by Panellit, Incorporated on Order NY-771896 with the following instruments furnished: Condensate storage tank level indicating receiver, hotwell level indicating receiver,

ondenser vacuum transmitter, low pressure drip pumps No. 3A nd No. 3B pressure indicators, condenser vacuum column, condensate pumps No. 3A, No. 3B and No. 3C pressure indicators, ondenser absolute pressure transmitter, condensate flow and ressure recorder, circulating water blowdown flow transmitter, irculating water auto-man selector control, circulating water lowdown computing relay, circulating water blowdown standatrol elay, condensate transfer pump switch and indicating lights nd main cooling tower on-off-reverse switches with indicating ights for Fans No. 3A thru 3I. Because of the crowded condition of piping in this panel which did not permit access for aintenance of instruments, additional openings were made for nstrument relocation and the piping modified.

The gland seal exhauster supplied by General Electric ompany on Order NY-771801 is mounted on the mezzanine platform, (Elevation 5138.50), adjacent to the west wall between column ines "12" and "12a" and exhausts the steam seals through a rainer to the hotwell.

ACCESSORY ELECTRICAL EQUIPMENT

Structural Features

Structural steel supports and aluminum screen enclosure for surge protection equipment were furnished by Muskogee Iron Works on Order NY-771921. The enclosure and supports are mounted on a generator leads support structure just outside the west wall, (column line "A"), of the station building between columns "14" and "14-1/2". A corrugated asbestos cement shed type roof at Elevation 5157 provides protection for this equipment, along with the generator lead wall bushings, from the elements, birds or rodents. Roof material was furnished by Corrugated Asbestos Contractors, Order NY-771904, and installed by our own forces.

Power Conversion Equipment

Power for operation of station auxiliaries is provided by use of an auxiliary transformer, 12,000/16,000 kva, oa/fa, 19,000 volt delta/4160 volt wye, 3 phase, 60 cycle, supplied by Westinghouse Electric Corporation on Order NY-771806. Primary power to the transformer is tapped from the generator leads between the station building west wall and the main power transformer, through a 12,000 volt gang operated disconnect switch, and the secondary is duct connected to the 4160 volt switchgear.

A reinforced concrete foundation, 7.5 cubic yards, was constructed immediately under the generator lead structure, eight (8) feet, three (3) inches north of column line "14" and twenty-eight (28) feet, nine (9) inches west of "A" column line, on June 19 for the mat, and on July 29 for the pier section, as recorded on Field Progress Drawing 3C-P-6, "Transformer Yard Foundations".

The transformer was shipped to the jobsite via rail and received less the radiators and oil. Our Northwest Model 80 crawler crane was used to unload the transformer and set it on its foundation. Installation of radiators and filling with oil were accomplished by Sturgeon Electric Company as part of their electrical contract. The radiator fans were tested and run-in on February 19, 1962.

A complete automatic fixed water spray type fire protection system is provided for the main and unit auxiliary transformers and the indoor turbine oil tank. A deluge valve is provided in the main supply pipe of each protected unit operated by impulse from a heat actuated device. The system is a dry type to prevent freezing, welded construction, spray type water nozzles, and was furnished by Viking Fire Protection Company, Order NY-771868, and installed by them on Order NY-771869. Concrete supports, (2.0 cubic yards), for this system were placed on October 27, and October 31, 1961. The pipe supply lines are all sloped so that the outdoor portion can be drained

to prevent freezing. The drain valves for the lines are located in a concrete pit containing 1 cubic yard of concrete with the slab placed March 21, and the walls March 27, 1962, located in the transformer yard near the point where the lines enter the building. A 4 inch drain line removes water from the box to the yard drainage system. The system was tested April 24, 1962.

Three (3) indoor station service transformers, each 750 kva, self-cooled (inerteen), 4160/480/227Y volts, 3 phase, 60 cycle, 11 percent impedance, were supplied by Westinghouse Electric Corporation on Order NY-771808, and are located within the confines of the switchgear room at Elevation 5130. Primary power is derived by cable thru duct bank from the 4160 volt switchgear and throat connected to unit power centers 3A and 3B and common power center C.

Three (3) outdoor station service transformers were also supplied by Westinghouse Electric Corporation on Order NY-771808.

The cooling tower transformer, 1000 kva oa/1150 kva fa cooled, 4160/480/277Y volts, 3 phase, 60 cycle, 11 percent impedance, is throat connected to its associated switchgear and is mounted on a common foundation for both pieces of equipment northwest of the southwest corner of the cooling tower.

The ash handling transformer, 550 kva, oa cooled, 4160/480Y/277 volts, 3 phase, 60 cycle, 6.5 percent impedance, is located on its reinforced concrete foundation, (1 cubic yard), placed December 4, 1961, seven (7) feet north and seven (7) feet east of column "Gb14" and is cable connected to its associated switchgear.

The remaining transformer serves the service water and pond discharge pumps having a capacity of 300 kva, oa cooled, 4160/480/277 volts, 3 phase, 60 cycle, 5 percent impedance. The transformer is mounted on a reinforced concrete foundation, (1.5 cubic yards), placed December 5, 1961, located northwest of Unit No. 1 cooling tower and is cable connected to its switchgear.

General Electric Company supplied a neutral grounding transformer, 50 kva, 20,000/240/120 volts, single phase, 60 cycle, askarel filled, with the 240 volt secondary connected to 0.52 ohm, 37 kw edgewise wound resistor as part of the turbo-generator order, NY-771801. This device is enclosed in a cubicle and mounted on the mezzanine level, Elevation 5138.50, of the turbine generator pedestal and is connected to the generator neutral bushing bus bar to accomplish grounding of the unit.

Also supplied by this vendor on the turbo-generator order were nine (9) bushing current transformers rated at 7000/5 amperes, single ratio, 60 cycle at 25 kv, for instrumentation and relaying purposes on the generator. Two (2) transformers are mounted on each neutral and one (1) on each line bushing.

dummy type holders are added to fill up space for three (3) transformers on each bushing.

An indoor metal enclosed cubicle containing four (4) potential transformers, compound filled, 25 kv insulation and bushings, 150 kv BIL, 175:1 turns ratio, 21,000/120 volts, 400 va normal rating and eight (8) type BAL current limiting disconnect fuses, rated 1/2 E amperes, 23,000 volts, 70,000 amps rms interrupting capacity, is located on the ground floor, Elevation 5130, directly under the enclosed isolated phase generator leads nine (9) feet inside the west wall (column line "A"). Primary taps from the generator leads supplies potential to this device for instrumentation and regulating purposes. Westinghouse Electric Corporation supplied this apparatus as part of the isolated phase generator leads on Order NY-771812.

The cubicle is mounted on a reinforced concrete foundation (3.5 cubic yards) placed April 19, 1961, as recorded on field progress drawing 3C-P-7, "Equipment Foundations", included elsewhere in this report.

All lighting requirements for the station building and outlying plant areas are provided for by seven (7) lighting transformers furnished by Westinghouse Electric Corporation on Order NY-771806. The electrical characteristics and location are as follows:

Designation	Location	Characteristics
No. 26	Sta Bldg-El 5132.5-Col B-12	45kva,3Ø,480/208Y/120V
No. 27	Sta Bldg-El 5145.7-Col Da-12	45kva,3Ø,480/208Y/120V
No. 28	Sta Bldg-El 5163.0-Col Da-11	30kva,3Ø,480/208Y/120V
No. 29	Sta Bldg-El 5149.2-Col Da-14	7½kva,1Ø,480/120/240V
No. 30	Sta Bldg-El 5163.0-Col B-14	30kva,3Ø,480/208Y/120V
No. 31	Boiler -El 5218.0-Col Gb-14	30kva,3Ø,480/208Y/120V
No. 32	Sta Bldg-El 5149.0-Col Da-14	30kva,3Ø,480/208Y/120V

Freeze protection requirements are satisfied by three (3) transformers, 15 kva, 480/208Y/120 volts, 3 phase, 60 cycle, dry type, supplied by Westinghouse Electric Corporation on Order NY-771806. Two (2) transformers are located on the boiler structure with No. 7 mounted on column "Fal2" at Elevation 5193.5 and No. 8 mounted on column "Fal4" at Elevation 5193.5. The remaining transformer, No. 9, is mounted on column "Dal3" at Elevation 5195.5 of the boiler structure. Heating requirements for outlying areas, such as the cooling towers and pond intake pumps, are derived from lighting transformers serving those areas.

The excitation cubicle supplied by General Electric Company as part of the turbo-generator order, NY-771801, is located on the mezzanine floor, (Elevation 5138.5), of the pedestal under the generator at the collector end. The three compartment cubicle is of indoor construction with compartments assigned as follows: One (1) compartment contains the generator deadfront field switch, 2 pole, 375 volts d-c, non-drawout type;

one (1) compartment containing the motor operated rheostat and amplidyne motor generator set; and the remaining compartment contains regulation equipment consisting of amplidyne voltage regulator control and accessories. Generator field leads and exciter leads enter the cubicle from the top.

Switchgear and Cubicles - 4160 Volt

The 4160 volt switchgear is located in the area designated as the transformer yard outside of, and adjacent to, the west wall of the station building. They are approximately thirty (30) feet west of the west wall, (column line "A") between column lines 13 and 14 extended.

The switchgear is outdoor, heavy-duty, metalclad type, in a double bus arrangement, with drawout type electrically operated air circuit breakers, 4160 volts, 60 cycle, 1200 amperes continuous rating and 250 mva interrupting capacity with an interruption time of 8 cycles. Each compartment, except the auxiliary compartments for potential transformers and cables, is complete with one vertical lift, horizontal drawout type air circuit breaker, bus and bus connections.

All breaker compartments, except compartment containing a spare breaker, are complete with current transformers, overcurrent, induction and other protective relays, alarm relay and instrumentation. All switchgear was supplied by Westinghouse Electric Corporation on Order NY-771807. The switchgear's main bus is directly connected, through an enclosed throat section, to the auxiliary transformer secondary. The cable feeders from the switchgear to the 4160 volt auxiliary motors and station power transformer primaries are through concrete encased fibre duct.

The foundation area was excavated into hard brown sandstone and blue Denver shale as shown in section on Drawing SK-7988-F32, "Sub-Surface Profiles", included elsewhere in this report. A B-22 Bucyrus Erie backhoe and manually operated air tools excavated a total of 225 cubic yards of material, which included all duct runs to the switchgear.

After all conduits were in place, 102 cubic yards of sand-cement encasement and fill were placed between August 7, and August 18, 1961, to bring the grade up to the bottom of the switchgear foundation.

The reinforced concrete foundation is shown on Drawing 59783, "Substation Facilities - Transformer Yard Foundations - & R - Sheet 2", and contains 40 cubic yards of class "B", -1/2 sacks of cement per yard, air entrained concrete placed August 29, 1961. Concrete placements are recorded on Field ogress Drawing 3C-P-6, "Transformer Yard Foundations", included elsewhere in this report.

Three (3) sections of outdoor metalclad switchgear, ch containing a type 50-DH-150-D air circuit breaker and

associated appurtenances were purchased from Westinghouse Electric Corporation on Order NY-771807. These compartments were installed with common 4160 volt switchgear at Unit No. 1 and occupy positions as follows: 6AC is for 480 volt common control center "C", on common switchgear "A"; 6BC is the motor feed for boiler feed pump No. 3C; and 7BC, is the feed for ash handling transformer on common switchgear "B".

A tie is provided, with automatic throwover, between the unit 4160 volt switchgear, compartments 2A and 2B, and Unit No. 2 4160 volt switchgear, compartments 10A and 11B, to provide power in the event of a fault which results in operation of the generator lockout relay or in the event the Unit No. 3 auxiliary power transformer is taken out of service. All switchgear was received early and stored adjacent to the foundation area. After the concrete was placed for the foundation, the switchgear was set on the foundation by use of our Northwest, Model 80 crawler crane.

Compartments of the Unit No. 3 4160 volt switchgear are assigned as follows:

Compartment	Service
1A	Feed from auxiliary transformer No. 3
1AX	Auxiliary compartment
2A	Standby-startup tie from Unit No. 2
3A	Cooling tower No. 3 transformer and service cooling water and pond discharge transformer
4A	Circulating water pump No. 3A
5A	Induced draft fan No. 3A
6A	Forced draft fan No. 3A
7A	Station service transformer No. 3A
8A	Boiler feed pump No. 3A
9A	Pulverizer mill No. 3A
10A	Pulverizer mill No. 3D
1B	Feed from auxiliary transformer No. 3
1BX	Auxiliary compartment
2B	Standby-startup tie from Unit No. 2
3B	Spare breaker
4B	Circulating water pump 3B
5B	Induced draft fan No. 3B
6B	Forced draft fan No. 3B
7B	Station service transformer No. 3B
8B	Boiler feed pump No. 3B
9B	Pulverizer mill No. 3B
10B	Pulverizer mill No. 3C

Control of all 4160 volt switchgear breakers is from the BTG board or BTG auxiliary board in the control room. Power for this function is 125 volt d-c.

Switchgear and Cubicles - 480 Volt

The unit auxiliary power supply system is split into an "A" and "B" group at both the 4160 volt and 480 volt levels. Motor drivers for sets of auxiliaries consisting of two or more identical units will be alternately connected to derive their power from the "A" and "B" systems, in order to maintain the maximum degree of reliability. The 480 volt auxiliaries directly associated with Unit No. 3 only are designated 3A and 3B and are seperately fed from the 3A and 3B 4160 volt switchgear which in turn is fed from the Unit No. 3 auxiliary transformer.

The existing common 480 volt system which is fed from the existing 4160 volt common system is extended for Unit No. 3 common equipment. An interconnection between Unit No. 3 and the common 480 volt systems is provided.

Westinghouse Electric Corporation supplied all the 480 volt switchgear on Order NY-771808 including cubicles for control centers. The main vertical bus in all 480 volt motor control centers and power centers, except the ash handling control center, was silvered aluminum in lieu of silvered copper. Experience with this type of bus in the local area proved unsatisfactory as heavy deposits would build up at connection points. Westinghouse Electric Corporation subsequently changed out all of this bus to silvered copper, at no cost to us.

The switchgear room is located on the ground floor (Elevation 5130) at the north end of the station building directly under the control room (Elevation 5155.0) and the cable vault room (Elevation 5142.0) between columns "B" and "Da", "14" and "15".

Two (2) complete sections of 480 volt switchgear, power centers No. 3A and No. 3B, are located within the switchgear room at Elevation 5130 and are throat connected to their associated transformers. The switchgear assemblage is indoor drawout type, containing electrically operated air circuit breakers. A tie is provided with automatic throwover to 480 volt switchgear No. 2A and 2B installed for Unit No. 2 extension. Compartments are assigned as follows:

Compartment	Service
3A-2	Relay & auxiliary control compartment
3A-3	Station service transformer 3A breaker
3A-4	480 volt switchgear "2A" tie
3A-5	480 volt valve control center No. 3
3A-6	480 volt control center 3A
3A-7	480 volt control center 3C
3A-8	Space for future use
3B-2	Relay & auxiliary control compartment
3B-3	Station service transformer 3B breaker
3B-4	480 volt switchgear "2B" tie
3B-5	480 volt control center 3B

Compartment	Service
3B-6	480 volt control center 3D
3B-7	Spare breaker
3B-8	Space for future use

One section of switchgear, 480 volt common power center C, associated with this equipment common to several units, is also located within the confines of the switchgear room. This indoor drawout type switchgear assemblage, contains electrically operated air circuit breakers. Compartments are assigned as follows:

480 Volt Common Switchgear "C"

Compartment	Service
3CC-2	Relay and auxiliary control compartment
3CC-3	480 volt common control center "D"
3CC-4	480 volt common control center "E"
3CC-5	480 volt H & V control center "D"

One section is part of a composite transformer power-control center arrangement for main cooling tower No. 3 fans. This section of apparatus is outdoor type and sets on a composite foundation with its associated transformer and control center at the southwest corner of No. 3 cooling tower. This switchgear, containing electrically operated air circuit breakers, is throat connected to both its associated transformer and control center. Compartments are assigned as follows:

480 Volt Cooling Tower No. 3 Switchgear

Compartment	Service
1A	Relay and auxiliary control compartment
1B	Cooling tower transformer No. 3
1C	Tie breaker

The 480 volt control centers are situated throughout the station building and outlying equipment to provide power in the areas of greatest demand utilizing a minimum of cable with resultant minimum loss of voltage. Westinghouse Electric Corporation on Order NY-771808, also supplied nine (9) indoor type and two (2) outdoor type 480 volt control centers for smaller unit and common motor controls on auxiliary rotating equipment.

Three (3) indoor control centers are fed from the 480 volt power center 3A and are designated and located as follows: Control center 3A is located approximately nine (9) feet west and three (3) feet south of column "Fa15" at Elevation 5130; control center 3C is located approximately three (3) feet east and six (6) feet south of column "Aa11" near the condensate pumps at Elevation 5130. Valve control center 3 is located approximately two (2) feet east and five (5) feet south of column "B11" at Elevation 5130. Compartments are assigned as follows:

480 Volt Control Center 3A

Compartment	Breaker Frame	Trip Elemt	Service
1D	100	15	Pulverizer mill feeder 3A-N
1F			Fuse and relay panel
1K	100	15	Pulverizer mill feeder 3A-S
2D	100	15	Pulverizer mill feeder 3D-N
2F			Fuse and relay panel
2K	100	15	Pulverizer mill feeder 3D-S
3BR	100	40	Spare breaker
3BL	100	20	Spare breaker
3D	100	15	Air heater 3A bearing oil pump
3F	100	15	do cooler fan
3H	100	50	Spare starter
3L	100	30	Air heater No. 3A
4D			Auto-throwover switch 120 v a-c dist panel No. 3
4G			120 v a-c distribution panel No. 3
4H	100	40	Primary brkr 15 kva distr transf No. 3
4K			15 kva, 1 phase, 480/120/240 v transf
5D	100	100	Service & coolg water return pump No. 4
5F	100	15	Spare starter
5H	100	70	Spare starter
5I			Space for future use
6BR	100	40	Spare breaker
6BL	100	100	Future electrostatic precipitator
6D	100	15	Spare pump No. 4 sulphite/morpholine
6F	100	15	Morpholine pump No. 1
6H	100	15	Phosphate pump No. 4
6K	100	15	I.D. fan 3A bearing blower
7BR	100	50	Lighting transformer No. 27
7BL	100	90	Soot blower power panel
7D			Space for future use
7K	400	300	Gas recirculation fan No. 3A

480 Volt Control Center 3C

1BR	100	40	Spare breaker
1BL	100	20	Spare breaker
1D			Space for future use
1K	400	15	Condensate pump No. 3B
2B		50	Spare starter
2D		70	Spare starter
2K	400	300	Turbine No. 3 auxiliary oil pump

480 Volt Control Center 3C--Contd

Compartment	Breaker Frame	Trip Elemt	Service
3BR	100	100	Main transf No. 3 cooling equip source "A"
3BL	100	50	Lighting transformer No. 26
3D	100	15	Lube oil filter pump
3F	100	15	Spare starter
3K	100	90	L.P. heater drain pump No. 3A
4B	100	15	Vapor extractor
4D	100	15	Gland exhauster No. 2
4F	100	15	Stator oil vacuum pump No. 3A
4K	100	90	Stator oil pump No. 3A

480 Volt Valve Control Center No. 3

1C	100	15	Boiler feed pump 3C discharge valve
1E	100	15	Boiler feed pump 3B discharge valve
1H	100	15	Boiler feed pump 3A discharge valve
1L	100	30	Main steam shut-off valve

Two (2) indoor control centers are fed from the 480 volt power center 3B and are designated and located as follows: Control center 3B is located approximately eleven (11) feet west and fifteen (15) feet south of column "Fa15" near the elevator shaft at Elevation 5130; Control center 3D is located north of the turbo-generator pedestal approximately seventeen (17) feet east and eight (8) feet south of column "Aa15" at Elevation 5130. Compartments are assigned as follows:

480 Volt Control Center 3B

Compartment	Breaker Frame	Trip Elemt	Service
1B	100	15	Phosphate pump No. 5
1D	100	15	Sulphite pump No. 5
1K	400	300	Gas recirculation fan No. 3B
2C	100	30	Air heater No. 3B
2E	100	15	Condensate transfer pump No. 3A
2H	100	70	Spare starter
2K	100	50	Spare starter
3BR	100	20	Spare breaker
3BL	100	40	Spare breaker
3D	100	20	Evaporator feed pump No. 4
3F	100	15	Air heater 3B bearing oil cooler fan
3H	100	15	Air heater 3B bearing oil pump
3K	100	15	I.D. fan 3B bearing blower
4BR	100	40	Lighting transformer No. 2B
4BL	100	40	Lighting transformer No. 31

480 Volt Control Center 3B--Contd

Compartment	Breaker Frame	Trip Elemt	Service
4D	100	50	Spare starter
4F	100	15	Spare starter
4K	100	100	Service & cooling water return pump No. 5

480 Volt Control Center 3D

1D	100	15	Pulverizer mill feeder 3B-S
1B			Fuses and relays
1K	100	15	Pulverizer mill feeder 3B-N
2D	100	15	Pulverizer mill feeder 3C-S
2F			Fuses and relays
2K	100	15	Pulverizer mill feeder 3C-N
3A	100	20	Spare breaker
3C	100	50	Amplidyne M-G set
3D	100	50	Space heater transformer No. 5
3F	100	15	Hydrogen seal oil vacuum pump
3H	100	30	Hydrogen seal oil pump
3L	100	70	Spare starter
4BR	100	40	Spare breaker
4BL	100	20	Spare breaker
4D	100	15	Gland exhauster No. 1
4F	100	15	Spare starter
4K	100	90	L P Heater drain pump No. 3B
5BR	100	100	Main trans No. 3 cooling equip source "B"
5BL	100	20	Unit auxiliary transf No. 3 cooling equipment
5D	100	30	Turning gear No. 3
5F	100	15	Stator oil vacuum pump No. 3B
5K	100	90	Stator oil pump No. 3B
6B			Space for future use
6D			Space for future use
6K	400	300	Condensate pump No. 3A
7B			Space for future use
7D			Space for future use
7K	400	300	Condensate pump No. 3C

Three indoor control centers are fed from the 480 volt common center C and are designated and located as follows: 480 volt common control center "D" located in the switchgear room at Elevation 5130; 480 volt common control center "E" is adjacent to valve control center No. 3 approximately two (2) feet east and eight (8) feet south of column "B11" at Elevation 5130; heating and ventilating control center No. 3, located west of the elevator shaft on the operating floor (Elevation 5155).

ompartments are assigned as follows:

480v Common Control Center "D"

Compartment	Breaker Frame	Trip Elemt	Service
1D	100	70	Battery charging M-G set motor
1FR	100	40	Lighting transformer No. 32
1FL	100	40	Alternate feed to 120v a-c distribution panel No. 3
1HR	100	40	Spare breaker
1HL	100	30	Station elevator M-G set motor
1K	100	70	Spare starter
2B			Space for future use
2K	600	450	Soot blower air compressor No. 6

480v Common Control Center "E"

1B			Space for future use
1K	600	450	Soot blower air compressor No. 8
2B			Space for future use
2K	600	450	Soot blower air compressor No. 7
3BR	100	40	Spare breaker
3BL	100	70	480 volt power receptacles
3DR	100	40	Lighting transformer No. 30
3DL	100	20	Lighting transformer No. 29
3F	100	50	Spare starter
3H	100	40	Spare breaker
3L	100	50	Turning gear oil pump

480 Volt Heating & Ventilating Control Center "D"

2B	100	15	Wall propeller fan E-26
2D	100	15	Vane axial fan E-27
2F			Space for future use
2H	100	70	Spare starter
2K	100	50	Spare starter
3BR	100	40	Air conditioning unit AC-3 fan & compressor
3BL	100	30	Electric unit heater No. 4
3D	100	15	Roof ventilator RV-15
3F	100	15	Roof ventilator RV-16
3H	100	15	Roof ventilator RV-17
3K	100	15	Roof ventilator RV-18
4B	100	20	Hot water circulation pump No. P-1
4D	100	15	Roof ventilator RV-19
4F	100	15	Roof ventilator RV-20
4H	100	15	Roof ventilator RV-21
4K	100	15	Roof ventilator RV-22

480 Volt Heating & Ventilating Control Center "D"--Contd

Compartment	Breaker Frame	Trip Elemt	Service
5BR	100	40	Spare breaker
5BL	100	20	Spare breaker
5D	100	30	Dry dust collector E-30
5H	225	150	Air washer S-5 centrifugal fan
5K	100	30	Air washer S-5 circulation pump
1B	100	15	Fan TF-1
1D	100	15	Roof ventilator RV-23 boiler drum end enclosure
1F	100	15	Roof ventilator RV-24 boiler drum end enclosure
1HR	100	30	Electric unit heater No. 5
1HL	100	30	Electric unit heater No. 6
1K			Space for future use

All the foregoing 480 volt control centers are cable connected to their respective unit or common switchgear.

An indoor 480 volt ash handling control center is located approximately six (6) feet east and six (6) feet south of column "Gb14" at Elevation 5130.

The ash handling control center is cable connected to its associated transformer outdoor whose primary feed is from compartment 7BC of the 4160 volt common switchgear (Unit No. 1) furnished and installed on Unit No. 3. Compartments are assigned as follows:

480 Volt Ash Handling Control Center

Compartment	Breaker Frame	Trip Elemt	Service
1B			Space for future use
1D			Space for future use
1K	400	300	Ash water pump No. 2
2B			Ash handling transformer ground relay
2D			Space for future use
2K	400	300	Ash water pump No. 1
3B	100	50	Ash sump pump No. 2
3D	100	50	Ash sump pump No. 3
3E	100	40	Spare breaker
3H	100	15	Ash clinker crusher No. 3A
3L	100	15	Ash clinker crusher No. 3B

One "walk-in" weatherproof outdoor housing is furnished for the 480 volt control center for cooling tower No. 3 fans and is located on a common reinforced concrete foundation with its associated 480 volt switchgear (power center) and 4160/480 volt

transformer whose primary is fed from the 4160 volt switchgear 3A. Compartments are assigned as follows:

480v Cooling Tower No. 3 Control Center

Compartment	Breaker Frame	Trip Elemt	Service
1K	400	350	Main cooling tower fan No. 3A
2K	400	350	Main cooling tower fan No. 3B
3K	400	350	Main cooling tower fan No. 3C
4K	400	350	Main cooling tower fan No. 3D
5K	400	350	Main cooling tower fan No. 3E
6K	400	350	Main cooling tower fan No. 3F
7K	400	350	Main cooling tower fan No. 3G
8K	400	350	Main cooling tower fan No. 3H
9K	400	350	Main cooling tower fan No. 3I
10A	100	70	Lighting transformer primary breaker
10C			Filler
10E			20 Circuit lighting panel
10F			Filler
10K			15 kva, 1 phase, 480/120/240v transformer

The foundation is located approximately eleven (11) feet west of the southwest corner of the cooling tower. The foundation contained 19 cubic yards and was concreted June 19, 1961.

One "walk-in" weatherproof outdoor housing is furnished for the 480 volt service water cooling tower and pond discharge control center as an extension to the existing control center. Controls in the existing control center were rearranged so the new extension is a unit operation and is fed from the unit 4160 volt switchgear 3A (Compartment 3A) with the cooling tower service. Compartments are assigned as follows:

480v Service Cooling Water & Pond Discharge Control Center

Compartment	Breaker Frame	Trip Elemt	Service
9D	800	800	Transformer tie breaker
9H	225	125	**Shallow well pump No. 4
9K			Space for future use
10D	100	30	*S.W. cooling tower fan No. 3 (7-1/2 hp)
10H	100	90	*S.W. cooling tower fan No. 3 (30 hp)
10K			Space for future use
11D	100	100	*Deep well pump No. 4
11H	225	150	Service cooling water pump No. 5
11K			Space for future use

480v Service Cooling Water & Pond Discharge Control Center--Contd

Compartment	Breaker Frame	Trip Elemt	Service
12B			Space for future use
12D			Space for future use
12K	400	350	Pond discharge pump No. 4

* Relocated from existing service water control center
** Relocated from existing water treatment control center

The service cooling water and pond discharge pump control center is located on an extension of Unit No. 1 control center foundation, (4.5 cubic yards), placed December 4, 1961.

All control centers consist of dead front metal housings containing 15,000 amp minimum interruption rated starter units consisting of a combination circuit breaker and full voltage magnetic contactor, with external manual reset thermal overload relays, a 3 phase, 600 volt, horizontal bus and a 3 phase, 300 volt, vertical bus.

Starters for the three soot blowing air compressors, compartment 2K on common control center "D" and compartments 1K and 2K on common control center "E", proved to be undersized when the equipment was started up. Westinghouse supplied six (6) capacitors, size 20 xvar, two (2) for each motor. The four (4) capacitors for compressors 7 and 8 were mounted in a spare compartment located at the south end of common control center E. The capacitors for the remaining compressor, No. 6, were mounted on top of common control center D and enclosed with sheet metal.

Heaters for the gas recirculating fan motor starters were inadequately sized and the motors tripped out when starting up. Numerous changes in the heaters failed to resolve the problem. Westinghouse solved the problem by furnishing current transformers and an inductive shunt to replace the heaters. The additional appurtenances are mounted in the starter cubicles.

Switchgear and Cubicles, 125 volt d-c

Royal Switchboard Company, Incorporated furnished the indoor, enclosed, dead front, self-supporting floor mounted d-c distribution panel, Order NY-771847, located in the switchgear room south of the battery M-G set, at Elevation 5130. Power is supplied to the panel from the station battery with a tie to Unit No. 1 distribution panel through a 250 ampere fuse. The motor generator set is tied to the panel also with a 200 amp disconnect breaker located at the bottom of the panel. This panel is arranged to serve the following equipment:

Connection	Amperes	Equipment
1	35	Transformer fire protection

nnection	Amperes	Equipment
2	60	Spare unit
3	35	Motor control center 3A
4	35	Motor control center 3C
5	35	Motor control center 3D
6	35	Reverse current valves
7	35	Steam temperature panel
8	35	Hydrogen panel
9	35	Turbine start-up panel
10	35	Operation recorder
11	35	Excitation cubicle
12	35	Purge protection panel
13	60	B T G board
14	60	Main control board
15	60	4160 volt switchgear 3A
16	60	4160 volt switchgear 3B
17	60	480 volt switchgear 3A
18	60	480 volt switchgear 3B
19	60	480 volt common switchgear "C"
20	60	480 volt control center No. 3
21	60	Auto-transfer switch L.P. No. 29
22	60	Spare unit
23	60	Spare unit
24	60	Spare unit
25	200	D-C control center

The 125 volt d-c control center located in the switchgear room, on column "C" and eight (8) feet, nine (9) inches south of column line "15" at Elevation 5130, was supplied by Westinghouse Electric Corporation on Order NY-771808. Feed to the center is derived from the d-c distribution panel setting on the same foundation and is connected by two (2) 1/c 250 mcm cables. Equipment served by this control center is as follows:

125 volt d-c Control Center

Compart-ment	Breaker Frame	Trip Elemt	Service
1B			Resistor compartment
1F	100	40	Emergency seal oil pump No. 3
1K	225	175	Emergency bearing oil pump No. 3
2B			Space for future use
2F	100	15	Vacuum breaker valve No. 3
2K	100	50	Spare starter
3B			Space for future use
3F	100	70	Boiler feed regulator block valve
3K	100	70	Boiler feed regulator by-pass valve

125 volt d-c Control Center--Contd

Compartment	Breaker Frame	Trip Elemt	Service
4B			Space for future use
4F	100	50	Circulating water pump No. 3A discharge valve
4K	100	50	Circulating water pump No. 3B discharge valve

Freeze Protection Panels

Three (3) freeze protection distribution panels are utilized in providing heat for water or steam lines exposed to extremely low atmospheric temperatures. Penn Panel and Box Company furnished these panels on Order NY-771888. The distribution panels are outdoor weatherproof type containing a 20 circuit panel board, 3 phase, 4 wire, 120/208 volt, with 20 amp, single pole, thermal-magnetic type branch circuit breakers, 9 adjustable resistors, 1 ohm, 200 watt with two sliders each, and 12 point terminal blocks. Two distribution panels are mounted on the boiler structure at Elevation 5197.0, HP-7 on column "Fal2", HP-8 on column "Fal4" and HP-9 is mounted on boiler column "Dal3" at Elevation 5189.50.

Three (3) indicating light (detection) panels each with 18 lights, white, watertight type, 2/3 volt, for use with the foregoing distribution panels were also furnished by Penn Panel and Box Company on Order NY-771888. The detection panels, HD-7, HD-8 and HD-9, associated with the freeze protection distribution panels are mounted on columns "Dal2", "Dal3" and "Dal4", at the lower firing aisle, (operating floor), Elevation 5155.0.

Space Heater Distribution Panel - 208/120 volt

Space heater requirements are adequately provided for by use of a transformer, 45 kva, 3 phase, 60 cycle, 480/208Y/120 volt, and two space heater distribution panels. The transformer supplied by Westinghouse Electric Corporation on Order NY-771806 is mounted on a concrete foundation, 1 cubic yard placed August 17, 1961, as recorded on field progress drawing 3C-P-6, "Transformer Yard Foundations", included elsewhere in this report. It is located in the transformer yard approximately thirty-nine (39) feet, west of column line "A" and two (2) feet north of column line "14" projected, with the secondary connected to space heater distribution panel No. 5 located adjacent to it and mounted on a generator lead support column. Space heater distribution panel No. 6 is located at the rear of the boiler above the ground floor, (Elevation 5130.0), and is mounted on column "Gbl3". Primary feed for space heater panel No. 6 is derived from lighting panel No. 27. The panels were supplied by Penn Panel and Box Company as part of Order NY-771888 with circuits assigned as follows:

208Y/120v Space Heater Distribution Panel No. 5

Circuit No.	Breaker Frame	Trip Elemt	Service
1	50	20	Mill No. 3A motor
2	50	20	Mill No. 3B motor
3	50	20	Mill No. 3D motor
4	50	20	Mill No. 3C motor
5	50	20	I.D. fan No. 3A motor
6	50	20	I.D. fan No. 3B motor
7	50	20	F.D. fan No. 3A motor
8	50	20	F.D. fan No. 3B motor
9	50	20	Spare
10	50	20	Spare
11	50	20	Spare
12	50	20	Spare
13			Dummy switch
14			Dummy switch
15	50	20	Spare
16	50	30	4160v Switchgear slab snow melting
17	50	30	B F pump 3A motor
18	50	30	B F pump 3B motor
19	50	30	Circulating water pump 3A motor
20	50	30	Circulating water pump 3B motor
21	100	30	4160v Switchgear No. 3A lights and heaters
22	100	30	4160v Switchgear No. 3B lights and heaters

208/120 Volt Space Heater Distribution Panel No. 6

1	50	20	I.D. fan No. 3A damper drives
2	50	20	I.D. fan No. 3B damper drives
3	50	20	F.D. fan No. 3A damper drives
4	50	20	F.D. fan No. 3B damper drives
5	50	20	Gas recirc fan 3A damper drives
6	50	20	Gas recirc fan 3B damper drives
7	50	20	Gas recirculating fan motor 3A
8	50	20	Gas recirculating fan motor 3B
9	50	20	Gas recirc cooling air damper drive
10	50	20	Spare
11	50	20	Spare
12	50	20	Spare

Lighting Load Centers

Lighting control panels were supplied by Penn Panel and Box Company, Order NY-771888, to be used with each of the lighting transformers. The transformer secondary is cable

connected to the panel main bus. Branch circuits of the panels gives control of all lights within the area served by the lighting panel. One remote lighting control panel was supplied for installation in the control room. Effective manual control of all lights in a given area is possible with this arrangement.

Locally mounted electrical appurtenances for control of motor driven auxiliaries are mounted near the dirven equipment. Motors which have controls at more than one point are kept to a minimum and such duplication exists only in cases where it is absolutely essential, such as the circulating water pump motors. Pressure or level sensing switches are used for control of electrical devices such as valves or motors to provide as much automatic operation as possible. Listed below are some of the local electrical controls and their respective vendors:

Push buttons & selector switches - Westinghouse Elec Corp - NY-771808
Selector switches - General Electric Company - NY-771841
Pressure switches - The Mercoid Corporation - NY-771909
Level switches - Magnetrol, Incorporated - NY-771911
Pressure switches - Barton Instrument, Corporation - NY-771922

Switchboards

The main electrical control board for control of transmission lines and switches and load frequency is a composite of new panels purchased from Westinghouse Electric Corporation, Order NY-771814, and existing panels purchased for Unit No. 1 and Unit No. 2. A total of four new sections of tunnel type duplex switchboard was purchased for this installation with three (3) sections installed in Unit No. 3 control room. The remaining section was installed in Unit 1 - 2 control room occupying position 6. This section of panel is utilized for control and instrumentation for the ring bus tie motor operated disconnect switches. The three sections for Unit No. 3 control room were assigned positions 2, 3 and 4 for load frequency control (No. 2), annunciation, battery control, audio tone channelizing equipment, and frequency recorder (No. 3), and instrumentation on the ring bus tie (No. 4).

Two (2) sections of panel were removed from Unit 1 - 2 control room and relocated in Unit No. 3 control room, positions 6 and 7 on the new board. Panel designated as No. 6 was purchased on Unit No. 1, Order NY-771312, while panel No. 7 was supplied with Unit No. 2 on Order NY-771814. The panels are used for control and instrumentation on Valmont-Washington circuit No. 1, Panel No. 6, and for Derby circuits 1 and 2, Panel No. 7. Public Service Company forces removed the panels from service and constructed temporary panels to function while the panels were relocated to Unit No. 3. Sturgeon Electric Company installed the new panels and relocated the two (2) existing panels. The new panels were factory wired and the connections to these panels were performed by Sturgeon on their general electrical contract, 3C-149. Wiring on the relocated panels was jointly performed by Sturgeon and Public Service Company forces closely coordinated by our electrical supervisor.

The hinged synchronizing panel attached to panel No. 7, relocated, is the one supplied for Unit No. 2 and a new panel was purchased for replacement on Unit No. 2. Westinghouse also furnished this panel on Order NY-771814 and it is hinged attached to new panel No. 6 in Unit No. 1 - 2 control room.

Line panel No. 2 houses equipment furnished by Leeds and Northrup Company, Order NY-771831, consisting of speedomax recorders; for recording megawatt generation on Unit No. 3, frequency and megavars, Lincoln thermal converter and auxiliary relays for audio-tone channelizing equipment. All of the above equipment was installed in the panel by Westinghouse as part of the switchboard fabrication.

A load frequency control console for remote control of station generation on Unit No. 3 was furnished by Leeds and Northrup on Order NY-771831. The self-supporting panel located in the control room contains three (3) console panels, seven (7) inches by seven (7) inches, and provides the setters necessary for controlling the base ranges for participation with the system frequency control program.

The carrier current panel purchased for Unit No. 1, Order NY-771831, Westinghouse Electric Corporation, on the Washington-Valmont No. 1 circuit was relocated from Unit No. 1 - 2 control room to Unit No. 3 control room. Public Service Company forces disconnected and reconnected the panel, although actual relocation was the function of Sturgeon Electric Company.

Protective Equipment

A manual gang operated 1200 amp continuous rating, 23 kv, 3 post insulator, disconnect switch is vertically mounted on the generator lead supports at the auxiliary power transformer. The switch was supplied by Westinghouse Electric Corporation on Order NY-771810 to disconnect the auxiliary transformer from the generator main leads.

Surge protection equipment consisting of three (3) capacitors, 23 kv, 0.125 mfd, single phase, 60 cycle, with 34/5 kv porcelain and three (3) lighting arrestors, outdoor type, rated voltage 15 kv, 19.5 rms, enclosed in a metal screen structure are located on the generator lead structure previously described under structural features. The capacitors were supplied by Westinghouse Electric Corporation on Order NY-771812 and the arrestors were supplied by General Electric Company as part of the turbine-generator accessories on Order NY-771801. One capacitor and one arrestor are tapped to each phase of the generator leads bus by means of a cable jumper. Connectors were supplied by Southern States Equipment Corporation, Order NY-771882; the porcelain roof bushings by Ohio Brass Company, Order NY-771849; and the cable by Anaconda Wire and Cable Company, Order NY-771884.

Conduits and Ducts

Procurement of all rigid conduit, fittings, pull boxes, terminal boxes and flexible steel conduit was through issuance of local purchase orders. Listed below are vendors of the major quantities of these items:

Conduit - Graybar Electric Company
Flexible Conduit - Graybar Electric Company
Conduit Fittings - Hendrie & Bolthoff Company
Pull Boxes - Metalcraft Welding & Fabricating Co.
Supports - Unistrut Western

Conduit was used for overhead electrical routing where the use of cable trays was not practical or was otherwise limited. Cable trays were used to greatest possible extent for routing of control cable in the station building areas. Conduit was used principally in routing power cables and control cables from cable trays to electrical apparatus. Cable trays were supplied by P. W. Industries, Incorporated on Order NY-771885.

Underground banks of electrical conduit throughout the station area and to outlying structures or equipment are basically a fibre duct material encased in concrete. Surplus transite and fibre duct were used and additional quantities were supplied by Graybar Electric Company on local order 3C-123. Rigid conduit was utilized on small size, under two (2) inches diameter, individual runs. The duct banks are encased in 320 cubic yards of concrete, placed intermittently as the duct was installed from December 19, 1960, to May 11, 1962.

In the station building area where a sand-cement backfill was used, the ducts were encased in this backfill. In areas where heavy loads from railroads and other facilities are imposed on the duct runs, reinforcing was added to the concrete.

All duct banks are provided with excess conduit either filling out the designated run or in some cases, a complete row of fibre conduit were added for future use. The duct bank for power and control cables to the switchyard was a joint effort by the electrical contractor and Public Service Company forces. All work within the switchyard fence area and connections to energized electrical apparatus was accomplished by Public Service Company personnel.

Reinforced concrete manholes and handholes were constructed at stategic locations to provide adequate pulling areas on underground duct banks. These locations were necessitated by long runs exceeding the requirements of the National Electrical Code or at junction points to reduce mechanical stresses in the cables. All manholes or handholes are equipped with drain lines to the nearest storm drain.

Number	Location
M H #24	Transformer yard, 38'-6" west of column line "A" and 9'-9" north of column line "15"
M H #25	Transformer yard, 28'-9" west of column line "A" and 13'-4" north of column line "11"
M H #26	Yard area to No. 3 cooling tower, 81' north of column line "15" and 51' east of center line No. 2 stack
M H #27	Yard area on run to No. 3 cooling tower, 70' north of column line "15" and 48" east of center line of stack
H H #15	Station building, 5'-2" south of column line "15" and 3'-2" east of column line "B"
H H #16	Cooling tower No. 3, 4'-4" south of south cooling tower column line and 16' west of center line cooling tower
H H #17	Station building 3'-0-1/2" west of column line "Gb" and 14'-3" south of column line "15"
H H #18	Boiler area, 8'-4" west of column line "Ha" and 4'-6" south of column line "12"
H H #19	Water treatment area, 27' north and 2'-6" west of northwest corner of the chlorine storage shed
H H #20	Water treatment area, 30'-6" north and 3'-0" east of the northeast corner of the chlorine storage shed
H H #21	Boiler area, 4'-9" east of column line "Ja" and 5'-6" south of column line "13"

Vertical cable raceways are provided in the station building from handhole No. 15 and handhole No. 17 to cable trays under the BTG and main control boards. The raceways are constructed of steel framing covered with asbestos cement transite siding. Material for the raceways was purchased locally and fabricated on the job.

Conductors and Insulators

Generator main leads between the generator terminals and the main power transformer are of two (2) types. The section within the station building proper, east of the west (column "A" line) wall, is of the totally enclosed isolated phase type and was furnished by Westinghouse Electric Corporation on Order NY-771812. The isolated phase bus is completely metal enclosed, 6500 amps, 23 kv, three phase, 60 cycle, 240,000 amperes rms momentary rated, including all insulators and accessories. All supports for the indoor section were included with the bus and are either hung from the station building structure or utilize the pedestal mezzanine floor for a support foundation.

A special aluminum (non-magnetic) frame contains the wall bushings where the generator leads exit through the concrete west wall and it was also furnished by Westinghouse Electric Corporation on Order NY-771812.

The outdoor section extending west from the "A" line wall to the main power transformer is of welded aluminum pipe construction as shown on design Drawing G-159896. This section was field fabricated from eight inch aluminum pipe, furnished by Reynolds Metals Company on Order NY-771867, supported by post

insulators furnished by Ohio Brass Company on Order NY-771849 on a galvanized structural frame, (six (6) tons) fabricated by Muskogee Iron Works on Order NY-771921. The flexible connectors to connect the isolated phase bus to the outdoor bus were furnished by Southern States Equipment, Order NY-771882, as was the connectors from the outdoor bus to the transformer. Bus clamps holding the bus to the insulators and welded aluminum bus fittings were furnished by Dossert Manufacturing Company on Order NY-771881. Erection of all components was the function of the electrical contractor.

Excavation for the generator lead support foundations was accomplished simultaneously with excavation for duct runs and transformer foundations. A Bucyrus Erie Model 22B backhoe was utilized in removal of 72 cubic yards of the hard Denver formation shale. Concrete for the foundations, 20.5 cubic yards, was placed intermittently between July 19, 1961, and September 12, 1961, with the actual placement dates recorded on field progress drawing 3C-P-6, "Transformer Yard Foundations", included elsewhere in this report.

Westinghouse Electric Corporation supplied a section of 2000/1200 ampere bus duct as part of their order for the 4160 volt switchgear, Order NY-771807, for throat connecting switchgear assemblages 3A and 3B to the secondary of the 12000/16000 kva, oa/fa, unit auxiliary power transformer. The bus is of weatherproof construction, completely metal enclosed with all accessories for attachment to the equipment on both ends of the bus.

Basic quantities of power wire and cable were supplied by Kerite Company, NY-771883, and Anaconda Wire and Cable Company, Order NY-771899. Cable remaining as surplus from Unit No. 1 and No. 2 construction was utilized in so far as practical to augment the basic cable orders.

Lineal Ft	Conductor	Vendor
2,007	1/c 750 mcm 5000 v ORAS	The Kerite Company
4,280	1/c 600 mcm 5000 v ORAS	The Kerite Company
17,078	1/c 3/0 awg 5000 v ORAS	The Kerite Company
3,297	1/c 750 mcm 600 v LMN	Anaconda Wire & Cable Co.
1,191	1/c 500 mcm 600 v LMN	Anaconda Wire & Cable Co.
2,301	1/c 350 mcm 600 v LMN	Anaconda Wire & Cable Co.
695	1/c 350 mcm 600 v LMN	Ryall Electric Supply Co.
4,129	1/c 250 mcm 600 v LMN	Anaconda Wire & Cable Co.
1,800	1/c 3/0 awg 600 v LMN	Anaconda Wire & Cable Co.
2,574	1/c 3/0 awg 600 v LMN	Surplus material
6,000	1/c #2 awg 600 v LMN	Anaconda Wire & Cable Co.
7,391	1/c #2 awg 600 v LMN	Surplus material
12,305	1/c #8 awg 600 v LMN	Anaconda Wire & Cable Co.
95	1/c #8 awg 600 v LMN	Surplus material
102	1/c #10 awg 600 v LMN	Ryall Electric Supply Co.
366	1/c #10 awg solid bare	Anaconda Wire & Cable Co.
10,335	1/c #12 awg 600 v LMB	Ryall Electric Supply Co.
421	1/c #12 awg solid bare	Anaconda Wire & Cable Co.

neal Ft	Conductor	Vendor
,122	1/c #18 awg 300 v TW	Graybar Electric Company
371	2/c 4/0 awg 600 v LMN	
,339	2/c 19/22 awg 600 v DEEP	Ryall Electric Supply Co.
,853	2/c 19/25 awg 600 v PEPP	Ryall Electric Supply Co.
,824	3/c 250 mcm 600 v LMNA	Anaconda Wire & Cable Co.
,387	3/c 19/25 awg 600 v PEPP	Ryall Electric Supply Co.

Control wire and cable were supplied by the following ndors and in quantities listed:

ineal eet	Conductor	Vendor	Order No.
135	1/c #10 awg 600 v LMB	Ryall Electric Supply Co.	NY-771892
896	1/c #10 awg solid bare	Anaconda Wire & Cable Co.	NY-771884
145	1/c #12 awg 600 v LMB	Ryall Electric Supply Co.	NY-771892
1,495	1/c #19/25 awg 600 v PEPP	Ryall Electric Supply Co.	NY-771892
5,782	2/c #19/22 awg 600 v PEPP	Ryall Electric Supply Co.	NY-771892
22,007	2/c #19/25 awg 600 v PEPP	Ryall Electric Supply Co.	NY-771892
15,146	2/c #19/25 awg 600 v PEPP	Hendrie & Bolthoff Co.	3C-1083
3,457	2/c #16 awg copper constantan	Leeds & Northrup Co.	NY-771901
5,000	2/c #16 awg iron constantan	Leeds & Northrup Co.	NY-771901
431	2/c #16 awg iron constantan	Surplus material	
1,672	2/c #19 awg 600 v PEPPS	Anaconda Wire & Cable Co.	NY-771899
550	2/c #19 awg 600 v PEPPS	Surplus material	
7,691	3/c #19/25 awg 600 v PEPP	Ryall Electric Supply Co.	NY-771892
3,032	3/c #19/25 awg 600 v PEPP	Hendrie & Bolthoff Co.	3C-1099
231	3/c 19/25 awg 600 v PEPA	Surplus material	
3,549	3/c #19 awg 600 v PEPP	Anaconda Wire & Cable Co.	NY-771899
7,386	4/c #19/22 awg 600 v PEPP	Ryall Electric Supply Co.	NY-771892
18,240	5/c #19/25 awg 600 v PEPP	Ryall Electric Supply Co.	NY-771892
3,029	5/c #19/25 awg 600 v PEPP	Hendrie & Bolthoff Co.	3C-1099
1,091	5/c #19 awg 600 v PEPPS	Anaconda Wire & Cable Co.	NY-771899
9,150	7/c #19/25 awg 600 v PEPP	Ryall Electric Supply Co.	NY-771892
4,000	7/c #19/25 awg 600 v PEPP	Hendrie & Bolthoff Co.	3C-1132
6,911	7/c #19/25 awg 600 v PEPP	PSCC Stores	
1,868	7/c #19/25 awg 600 v PEPA	Ryall Electric Supply Co.	NY-771892

Lineal Feet	Conductor	Vendor	Order No.
5,894	9/c #19/25 awg 600 v PEPP	Ryall Electric Supply Co.	NY-771892
2,160	12/c #19/25 awg 600 v PEPP	Ryall Electric Supply Co.	NY-771892
3,291	12/c #19/25 awg 600 v PEPP	Surplus material	
1,480	25/c #19 awg 600 v PEPPS	Anaconda Wire & Cable Co.	NY-771899
773	RG-59/4 coaxial cable	Interstate Radio Company	3C-1130

All terminals, connectors, caps, twine and tags were purchased locally. Tape and compound for terminations or splices were furnished by the electrical contractor as part of the installation contract.

Auxiliary Equipment

Direct current requirements for control and operation of direct current motors is satisfied by a 60 cell battery, lead-acid type, located in the switchgear room, Elevation 5130, along the north wall. The Electric Storage Battery Company, Exide Industrial Division, furnished the battery with its two-step storage rack and connectors on Order NY-771842. Also included by this order is a 20 kw diverter pole motor-generator set for charging the battery. Controls for the generation equipment are mounted on the main control board in the control room to afford better control operation. A tie is made between the new battery and the battery furnished for Unit 1 - 2. An automatic throwover switch on the system provides power for normal-emergency lighting circuits and emergency equipment circuits in the event the unit is tripped with a subsequent loss in auxiliary power.

Grounding

Grounding of all structures, equipment and facilities is accomplished by a network of No. 4/0 and No. 2/0 bare copper cable throughout the station building and boiler area. This is connected to the main ground loop composed of black iron strap and No. 4/0 polyethylene coated wire in the transformer yard and a polyethylene coated copper cable, No. 4/0, tie to the black iron strap on yard lighting along the east plant road, and is shown on design drawing G-130752.

Connections between cables, iron straps and structural steel were fused connections using the Cadweld process. Cadweld cartridges were purchased locally. Southern States Equipment Company, Order NY-771882, and Dossert Manufacturing Company, Order NY-771881, furnished the connectors for attachment of the grounding cable to equipment. Two additional ground rods were specified in the transformer yard; however, due to the presence of Denver shale at the ground level, it was impossible to install the rods.

The ground system is tied to the negative lead of a 0 ampere cathodic protection rectifier, furnished on Unit No. 1 or ground bed No. 1, relocated to Column "Hall-3/4" at Elevation 135. A new 75 ampere rectifier, furnished by Corrosion Rectifying ompany on Order NY-771905, replaced the existing rectifier on round bed No. 1. The existing rectifier was relocated with its ositive leads connected to ground bed wells No. 4 and No. 5.

The ground wells are 10 inch diameter pipe casings, nstalled in a seventy-five (75) feet deep drilled hole, in hich eight (8) graphite anodes are suspended on a loop of No. /0 insulated cable and filled with coke breeze. Ground well o. 4 is located in the boiler area outside the building near olumn "Jal2", and ground well No. 5 is located in the yard near .H. No. 27 on the duct run to No. 3 cooling tower. Both were rilled and cased by Meredith Drilling Company on Order 3C-834. The anodes and coke were also furnished by Corrosion Rectifying Company on Order NY-771905. Cable for the system was supplied by Anaconda Wire and Cable Company on Order NY-771899.

Cathodic protection requirements for the condenser are satisfied by the installation of two (2) 30 ampere, constant current (self regulating), d-c rectifiers, in conjunction with four (4) Durion button type anodes installed in each of the four (4) water boxes, and connected to the positive terminal of the rectifier. The negative lead from the rectifier is connected to the water box. A zinc reference anode is installed in each water box for testing the system. All equipment for this system was furnished by Corrosion Rectifying Company, Order NY-771905. The cable for connecting up the system was furnished by Anaconda Wire and Cable Company on Order NY-771899.

MISCELLANEOUS POWER PLANT EQUIPMENT

Service Equipment

The vacuum cleaning system is an extension of the existing system for Units No. 1 and 2 and is shown on design drawing G-159656, "Vacuum Cleaning System". There are eighteen (18) nickel plated inlet valves furnished by Spencer Turbine Company on Order NY-771913, and an additional one (1) furnished by the same vendor on local order 3C-447. The piping was purchased from H-P Products, Incorporated on local order 3C-932 and installed by our pipefitter forces. The nineteen (19) convenience outlets are located in the station building as follows:

1 - Plant Betterment Area - El 5156'
2 - Fan Room - El 5142'
4 - Firing Aisles - El 5156', 5164', 5171', 5180'
2 - Pulverizer Areas - El 5131' and 5139.5'
2 - Chemical Treatment Area - El 5131' and 5143'
2 - Control Room - El 5156'
1 - Switchgear Room - El 5131'
5 - Turbine Room - 3-El 5156', 1-El 5139.5', 1-El 5131'
1 - Cable Vault - El 5143'

Chemical fire extinguishers are located throughout the plant area at places designated by Mr. Larry Burt, the plant chief engineer. There are forty-four (44) 20 pound General CO_2 extinguishers, Model 20-R, and two (2) 75 pound General CO_2 wheeled cart type extinguishers, Model 75-R, furnished for this unit. In addition, one 500 foot capacity steel wheeled hose cart is furnished, type WD Allen, Figure 7137-3, complete with 300 feet of $1\frac{1}{2}$ inch cotton rubber lined double jacket fire hose including adaptors and nozzles. All of this material was supplied by Grinnell Company on local order 3C-892.

Intrasite communication equipment installed for Unit No. 1 satisfied the basic requirements with only telephone and code call stations required for Unit No. 3. The arrangement is shown diagramatically on design drawing G-159925, "Communication System", included elsewhere in this report. Stromberg Carlson supplied all equipment on Order NY-771805 which consists of the following: Two (2) desk telephones, thirteen (13) wall telephones, five (5) outdoor telephones, ten (10) acoustic booths and indoor and outdoor code call horns, chimes and bells. Conduit was field run to all equipment and was purchased from Graybar Electric Company on Order 3C-123. The 2/c #19 awg 300v PEP twisted pair cable, was supplied by Anaconda Wire and Cable Company on Order NY-771899, (5,100 lineal feet), and by Graybar Electric Company on Order 3C-1023, (5,000 lineal feet). Installation was made by Sturgeon Electric Company on their general electrical contract, 3C-144.

An intercom communication system, Executone, Series 3700, for paging and talking between the Unit No. 3 control room and the firing aisles of Unit No. 3 boiler and future Unit No. 4

er, was also installed. This equipment was purchased from utone Incorporated on Order NY-771851. This order also ludes on-the-premises maintenance furnished by Executone Com- of Denver during normal working hours at no cost for a iod of twelve (12) months from the date of installation com- tion, unless damage is caused through misuse or accident. booster amplifier supplied under Item 4 of the order rated atts, was too small to provide sufficient volume and this lifier was replaced with one having a 24 watt rating and the ration is satisfactory.

Station air at 100 psig is furnished at convenient lets throughout the plant similiar to the existing system. t No. 3 station air is an extension to the system in service r Units No. 1 and 2, thus eliminating the necessity of in- alling any new equipment. Piping installation was accomplished our forces.

neral Plant Equipment

An eight (8) ton Yale and Towne Rail Hugger chain type nd hoist with a geared trolley was furnished by Coursey Equip- nt Company on local order 3C-812. It has a 14 foot lift and n be used on any of the three (3) monorails over the boiler ed pumps or the four (4) monorails over the coal pulverizer ills. The monorails for the boiler feed pumps were furnished Metalcraft Welding and Fabricating Company on local order C-793. The monorails over the coal mills were furnished by terling Steel Company on local order 3C-77.

TRANSMISSION PLANT

SUBSTATION STRUCTURE AND IMPROVEMENTS

Improvements to Site

Grading in the switchyard and transformer yard area was accomplished during construction of the original unit with only fine grading and gravel surfacing in the transformer yard required for Unit No. 3. Gravel surfacing with 3/4 inch crushed stone 4 inches thick was accomplished concurrently with the surfacing in the boiler area. Surfacing in the switchyard was accomplished during foundation construction by Public Service Company forces. Material totaling 326 tons was supplied by Boise Cascade Sand and Gravel Company, Order 3C-788, and spread by our forces during the spring of 1962. Provisions for additional lighting to accomodate the new structures added in the switchyard are satisfied by installation of additional lighting fixtures by Public Service Company forces. The fixtures were furnished by General Electric Supply Company on Order NY-771880 and installed during the month of April, 1962. Wire for the additional fixtures was supplied by Ryall Electric on Order NY-771892.

SUBSTATION EQUIPMENT

Structural Features and Improvements

Construction of all foundations and erection of all structures in the switchyard proper were accomplished by Public Service Company of Colorado forces. Excavation was started the first week of January, 1961, and was limited to handwork with air driven tools due to insufficient clearance on overhead structures. Concrete for the foundations, 58 cubic yards, was supplied by Ready Mix Concrete on Order 3C-17 with placements made between March 16, and March 30, 1961, and recorded on Field Progress Drawing 3C-P-11, "Substation Foundations", included elsewhere in this report.

In the transformer yard, a pull-off tower straddles the three (3) phase main power transformer for the slack span tie to the switchyard. Excavation in the hard Denver shale for the foundations was accomplished by use of a one cubic yard backhoe rented from Gilbert Clark on Order 3C-27, and fine grading with our labor forces using air driven tools. Concrete, 43.0 cubic yards, was placed between July 14, and August 18, 1961, with actual placements recorded on field progress drawing, 3C-P-6, "Transformer Yard Foundations," included elsewhere in this report. Anchor bolts and miscellaneous steel embedded in concrete were purchased from Metalcraft Welding and Fabricating on Order 3C-187.

Structural steel for the two (2) towers with their connecting trusses, composing the transformer pull-off structure, and the similiarly arranged tie tower structure in the switchyard

was detailed and furnished by Muskogee Iron Works on Order NY-771921. This order also included all the supporting structures for potential transformers and bus support in the switchyard and generator leads. All the galvanized steel, 21 tons, arrived in one carload and was sorted out for the various structures by a composite crew made up of Public Service Company of Colorado and Sturgeon Electric employees. The tie tower structure in the switchyard was subsequently erected by Public Service Company of Colorado forces during December, 1961. The transformer pull-off structure was erected by Strugeon Electric Company under terms of their general electrical installation contract, 3C-194, in the spring of 1962.

Power Conversion Equipment - Transformers

The foundation for the main power transformer is shown on Drawing G-159782, "Substation Facilities - Transformer Yard Foundations", and is located approximately fifty-nine (59) feet west of the station building west wall ("A" column line) and eight (8) feet north of column line "14" projected. Excavation was accomplished by removing the shale and sandstone formations, 46 cubic yards, with a Bucyrus Erie, Model 30B, one (1) cubic yard backhoe rented from Gilbert Clark on Order 3C-27. For a typical cross section of the soil stratums see field sketch SK-7988-F32 included elsewhere in this report. The excavation was large enough to include a sump of adequate capacity to contain the oil from the transformer should an emergency condition arise that would require dumping the oil. A total of 148 tons of 1-1/2 inch minimum size rock furnished by Boise Cascade Sand and Gravel Company on Order 3C-788 was used as backfill in the sump. A perforated vitrified clay pump sump and a drain line with a valve are provided as methods of draining the sump.

Concrete, 27.5 cubic yards, was placed for the foundation mat on July 17, the pier section on August 17, 1961, and is recorded on field progress drawing 3C-P-7, "Transformer Yard Foundations," included elsewhere in this report. Railroad rail used as embedded supports were fabricated from stock rail by Public Service Company in the Cherokee maintenance shop.

The main transformer is rated at 180,000 kva, 140,000 volt wye/19,000 volt delta, 3 phase, 60 cycle, with forced oil and air cooling and was supplied by Westinghouse Electric Corporation on Order NY-771805, in accordance with specification PSCC-3C-177. The transformer is equipped with high altitude bushings, lightning arrestors and forced oil and air cooling equipment.

The transformer, weighing 123 tons less the above listed accessories and oil, was shipped on a special low bed railroad car and was skidded off the car onto the foundation by our rigger forces using a power winch truck on September 14, 1961. Sturgeon Electric trimmed out the transformer thereafter under terms of their general electrical contract.

The forced oil and air cooling system is equipped with an automatic starting circuit three element relay activated by the winding temperature. The control circuit to the relay is fed from either 480 volt motor control center 3C or 3D and an alarm and signal circuit is connected to the 125 volt d-c distribution panel.

One current transformer, outdoor, type VO-15, 110 kw, 1200/5 ampere ratio, was purchased from Westinghouse Electric Corporation, Order NY-771815, and installed on the high voltage neutral bushing for use in current polarizing of the directional relays. Sturgeon Electric forces installed this transformer concurrently with the trim on the main transformer.

Channel ribs used as reinforcement for the tank shell were also utilized as troughs to convey control cables from the control compartment to fans, pumps, relays, etc. The access holes into these channels were fitted with incorrect size gaskets which resulted in water entering the troughs and corroding the contact surface of plugs and receptacles. Westinghouse accepted the responsibility for correcting this condition. Westinghouse was also required to repair a leak that developed in a weld connecting the tank to its bottom. The leak was repaired by one of our certified pipe welders under the direction of a Westinghouse representative.

A fire protection system for the main transformer was supplied and installed by Viking Sprinkler Company, Incorporated on Orders NY-771868, material, and NY-771869, erection. Two other legs of this system protect the unit auxiliary transformer and the turbine lubricating oil tank. The system is an automatically operated fire protection system of the fixed water spray type, with water fog nozzles; operated (1) by a rate rise, heat actuated device, (2) by a transformer fault relay and (3) by a manual pull box.

All electrical equipment for the fire protection system is 125 volt d-c fed from d-c distribution panel No. 3. Installation of the system was accomplished by Viking during March, 1962.

Concrete supports for the system were constructed on October 25, 1961, 2.5 cubic yards, by our forces. The drain valve pit described with the fire protection system for the auxiliary transformer also serves this system.

Protective Equipment

The switchyard for Units No. 1 and No. 2 was a ring bus arrangement with protective devices arranged to isolate various circuits. With the addition of Unit No. 3, the switchyard was rearranged into a double ring bus arrangement with a tie air circuit breaker connecting the north half, Unit No. 3 from the south half, Units No. 1 and No. 2, as shown on Drawing G-130780R7 "115 kv Switchyard - Plan". All work requisite to revising the switchyard and additions for Unit No. 3 were accomplished by

lic Service Company of Colorado forces.

Construction of concrete foundations was started in 9 when concrete, 33 cubic yards, purchased by Public Service mpany of Colorado from Centennial Concrete Company, was aced for one oil circuit breaker foundation and two foundations a "C" tower in the month of May. The remaining foundation rk was started the first week of January, 1961, and completed April 10, 1961, with 96.0 cubic yards of concrete used. concrete was supplied by Ready Mix Concrete on our order, -17, and actual placement dates are recorded on field progress awing 3C-P-11, "Substation Foundations," included elsewhere this report.

Galvanized structural steel, one and one-half (1.5) ons, for nine (9) potential transformer supporting structures nd one bus support BSS-4, were detailed and fabricated by uskogee Iron Works on Order NY-771921. Public Service Company laced an order for 14 tons of galvanized steel with Schuler ngineering Company which included five (5) C and five (5) structures. Four existing BSS-1 bus support structures were emoved to accomodate the new construction. The supporting tructures were erected during the month of December, 1961.

Three (3) oil circuit breakers were purchased from estinghouse Electric Corporation on Order NY-771809. The breakrs are 115 kv, 1200 amps, 5000 mva interrupting rating, 3 phase, neumatic operating mechanism with 125 volt d-c controls and ere added to the ring bus.

The OCB's are used to; isolate generator No. 3 from he ring bus, located in the east bus at line 12; isolate the almont diagonal circuit from the ring bus, located on line 9 between the east and west busses; and to isolate generator No. 2 rom the ring bus, located in the east bus on line 8.

A local order, 3C-337, was placed with Weicker Transfer ompany to unload and haul the breakers to the switchyard. The reakers were completely assembled with all internals, bushings, nd current transformers attached to the tanks and only the illing with oil was required after they were set on their oundations.

Eight (8) air break switches were purchased from estinghouse Electric Corporation on Order NY-771810. One (1) ir break switch is used to isolate the No. 3 generator tie, one s used to tie the double ring bus together and the remaining ix (6) are for sectionalizing the ring bus. Public Service ompany also supplied one (1) additional air break switch from heir stock for sectionalizing. The sectionalizing air break witches are gang type V-2, 115 kv, 1200 amps, 3 pst, horizontal pright mounted, with short arcing horns, and an indirect conected manual geared type operating mechanism. The two (2) ther switches supplied by Westinghouse are gang type V-2, 115 kv, 200 amps, 3 pst, horizontal upright mounting, with short arcing orns, and type T-3 motor operators with 125 volt d-c control nd 115 volt a-c space heaters.

Nine (9) outdoor potential transformers were purchased from Westinghouse Electric Corporation on Order NY-771815 for instrumentation and relaying on the 115 kv bus. Transformers are type APT, 115 kv, oil filled with a single bushing.

Conductors and Insulators

The 115 kv double ring bus is of low bay construction with three conductors, spaced at ten foot per phase, of four inch sps aluminum pipe welded in all current carrying connections. The vendors and quantities of material installed in the bus construction are as follows:

Quantity	Item	Supplier	Order No
8 each	Pin Cap Insulators	PSCC	PSCC Stores
9 each	Expansion Terminals	Burndy Corporation	NY-771823
6 feet	1¼" Sch 40 alum pipe	Reynolds Metals Co	NY-771867
66 feet	2½" Sch 40 alum pipe	Reynolds Metals Co	NY-771867
2 feet	3½" Sch 40 alum pipe	Reynolds Metals Co	NY-771867
36 each	Bolted Connectors	Dossert Mfg Co	NY-771881
59 each	Weld Fittings	Southern States Equip	NY-771882

Bare conductor and connectors for the slack span from the pull-off tower at the main transformer to the receiving tower in the substation were purchased from Ohio Brass Company, suspension insulators and hardware on Order NY-771849, and Reynolds Metals Company, compression connectors on Order NY-771867. Other wiring included the jumpers from the 115 kv ring bus to the potential transformers and wiring associated with the lightning arrestors on the main power transformer. The following vendors supplied material for these functions.

Order No.	Supplier	Material
NY-771881	Dossert Manufacturing Company	Connectors
NY-771882	Southern States Equipment Company	Connectors
NY-771883	Ryall Electric Supply Company	Insulated Cable

Wire and fittings for the aerial shield system were supplied by Ohio Brass Company, Order NY-771849 for hardware, and the wire was from Public Service Company stores.

RETIREMENT WORK IN PROGRESS

The original project planning was based on a site development for an ultimate six units. The basic substation provided a 115 kv switchyard with a ring bus for six separately protected transmission circuits in addition to the main power transformer (Generator No. 1) and the standby-startup transformer. Also provided was space for generator circuits for future Units No. 2, No. 3 and No. 4 with their separate protection and plans to sectionalize the Unit No. 1 and No. 2 ring from the Unit No. 3 and No. 4 ring through a motor operated disconnecting switch when Unit No. 3 was installed.

To accomplish the ring bus sectionalizing and addition of protective equipment, certain sections of the welded 4 inch aluminum bus had to be removed and either refabricated or retired. The following items were retired: 189 feet, 4" aluminum pipe; 18 each, O.B. bus insulators, pin type; 9 each, 4" aluminum bus clamps; 9 each, 4" aluminum bus adaptors.

The shield wire along the east side of the switchyard was transfered to the new Unit No. 3 generator take-off tower and one (1) sixty-five (65) foot wood pole was retired.

Control of the existing protective equipment in the switchyard now associated with the separated sectionalized ring bus for operation in the Unit No. 3 control room was removed from the Unit No. 1 - 2 control room. The panel changes and rearrangement are detailed in the specific history section of this report under Accessory Electrical Equipment - Switchboards. The control cable rearrangement required reconnections, relocations, reuse and retirements. All of the installations in the Unit No. 1 - 2 control room and switchyard were performed by Public Service Company of Colorado forces and the new installation and connections in the Unit No. 3 control room were performed by Sturgeon Electric Company under items in their general electrical contract working with the operating companies forces at the switchyard end. The following quantities of cable were retired from property records and returned to stores or scrapped: 107 feet, 2/C No. 10 Simplex 600 volt LMNA; 95 feet, 4/C No. 10 Rome 600 volt PEPP; 234 feet, 7/C No. 12 Rome 600 volt PEPP; 124 feet, 9/C No. 12 Rome 600 volt PEPP; 142 feet, 12/C No. 12 Rome 600 volt PEPP; 217 feet, 5/C No. 14 Rome 600 volt PEPP, 6 each, connectors; 315 pounds, copper wire (scrapped).

A 550 foot section of an existing 7 foot high chain link fence (internal fencing) along an original property line and left in place after purchase of the adjoining property as protection during gravel removal was removed and retired.

PHYSICAL DATA - PROJECT

Location: Adams County, Colorado
Mailing Address: 6198 Franklin Avenue, Denver 16, Colorado
Entrance: East 62nd Avenue at Franklin Street, Adams County
Common Carrier: Denver & Rio Grande Western Railroad Company

Land Area of Site: 160.325 acres
Area of River Water Settling Ponds: 7.17 acres
Area of Ash Settling Ponds: 1.51 acres
Paved Roads: 1.56 miles
Railroad Trackage: 4.82 miles

Elevation of Yard Grade - 5129.50
Elevation of Plant Operating Floor - 5155.0
Elevation Top of 300 foot Chimney - 5430.0
Elevation Top of Sign on Boiler No. 1 - 5297.33

GENERAL DATA - UNIT NO. 3

Earth Excavation: 32,950 cubic yards
Rock (Shale) Excavation: 4,340 cubic yards
Concrete: 9,596 cubic yards
Reinforcing Steel: 538 tons
Structural Steel, Building: 880.7 tons
Structural Steel, Boiler: 660 tons
Miscellaneous Steel: 127 tons
Paint - Prime and Finish: 3,100 gallons
Electrical Conduit: 15.5 miles
Electrical Wire and Cable: 59 miles
Boiler Plant Piping Systems: 12.1 miles
Boiler, Pressure Parts, Tubing: 61.2 miles
Condenser Tubes: 45.7 miles
Chimney Brick: 217,500 each

Expendable Material
- Gasoline and Oils: 34,337 gallons
- Oxygen: 126,000 cubic feet
- Acetylene: 60,000 cubic feet
- Welding Rod: 9.0 tons
- Lumber: 70,600 feet board measure
- Nails: 3 tons

Elevation Top of Unit No. 3 300 foot Chimney - 5430.0
Elevation Top of Unit No. 3 Boiler Structure - 5285.5

Actual Workdays: 540
Largest Construction Force: 300 men, September 27, 1962
Mandays of Construction: Approximately 86,673

CHRONOLOGY OF JOB HIGHLIGHTS

June 1961	Assemble construction organization
June 13, 1960	Start earth excavation - station building and boiler areas
June 20, 1960	OFFICIAL STARTING DATE - ground breaking ceremonies
June 21, 1960	Start drilling caissons - station building foundations
July 5, 1960	Start shale excavation - turbine generator foundation
July 11, 1960	Start shale excavation - station building west wall
July 18, 1960	Complete foundation caisson drilling and concreting
July 21, 1960	First concrete placed - station building foundations (Column C-12)
July 25, 1960	First concrete placed - boiler foundations (Column Da-12)
ugust 2, 1960	Start excavation - chimney foundation
ugust 24, 1960	Concrete placed - chimney foundation mat
tember 20, 1960	Concrete placed - chimney foundation plinth
tober 14, 1960	Concrete placed - turbine generator foundation mat
tober 27, 1960	Erect first column (C-11) - station building structure
ember 12, 1960	Erect first column (Da-12) - boiler structure
nuary 18, 1961	Complete concrete placing - turbine generator pedestal
ruary 20, 1961	Start setting baseplates - turbine generator unit
ruary 24, 1961	Raise boiler steam drum (146 tons)
April 18, 1961	Setting low pressure exhaust - turbine erection
April 20, 1961	Unload and set - generator stator (168 tons)
June 16, 1961	Start stripping and excavation - ash settling ponds
ugust 15, 1961	Complete concrete placing - C. W. cooling tower basin
ugust 28, 1961	Start erection - C. W. cooling tower superstructure
tember 12, 1961	Operate soot blowing air compressor No. 7 - for plant service
tember 14, 1961	Unload and set - main power transformer (125 tons)
ember 27, 1961	Peak construction force - 300 men
tober 20, 1961	Complete coal handling changeover - conveyors No. 5A and 5B
ember 9, 1961	Complete erection - C. W. cooling tower superstructure
nuary 3, 1962	Unload last coal pulverizer mill
nuary 5, 1962	Complete 3225 psi hydrostatic test - boiler pressure parts
nuary 19, 1962	Complete 990 psi hydrostatic test - boiler reheater
nuary 24, 1962	Energize 4160 volt switchgear
March 2, 1962	Complete 4250 psi hydrostatic test - boiler feed system
March 8, 1962	Pilot (natural) gas to ignitors
March 9, 1962	Light off pilot ignitors - boiler dry-out and boil-out
March 14, 1962	Complete boiler dry-out and boil-out
March 21, 1962	Energize 480 volt switchgear - common control center D & E
March 29, 1962	Turbine generator unit - on turning gear
April 4, 1962	Fuel (natural) gas to main burners - boiler
April 6, 1962	Complete blowing out - main steam piping system
April 9, 1962	Complete blowing out - cold reheat piping system
April 16, 1962	Complete blowing out - hot reheat piping system
April 27, 1962	Turbine first rolled with steam
April 28, 1962	TRIAL OPERATION REALIZED - 5:31 p.m.
May 12, 1962	Ash handling and sluicing system in operation
May 15, 1962	Boiler first fired with coal
May 23, 1962	Unit generating 150,000 kilowatts
May 29, 1962	Complete bearing inspection (No. 4 & No. 5) - turbine generator unit
June 5, 1962	Complete reassembly of turbine stop valves after fine screen removal
June 6, 1962	Complete acid cleaning - boiler
June 15, 1962	COMMERCIAL OPERATION REALIZED
gust 7, 1962	Unit full load test at rated conditions - 163,000 kilowatts
ober 15, 1962	Turbine full throttle valve test - 174,000 kilowatts